Predicting disability, pain and work capacity after surgery for a Lumbosacral Radicular Syndrome

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CHAPTER 1

Predicting disability, pain and work capacity after surgery for a Lumbosacral Radicular Syndrome: general introduction

Lumbosacral radicular syndrome (LRS) is one of the few back-related disorders in which there is a clear concept of the pain pathogenesis (Spitzer et al., 1987; Koes et al., 2001). In 90% of the patients, LRS is caused by mechanical and chemical irritation of a lumbar or sacral nerve root by extended disc material (Mixter & Barr, 1934; Nachemson, 1992; Boos et al., 2000). The symptoms of LRS are characterized by irradiating pain in an area of the leg typically served by the compressed lumbar or sacral nerve root. In about 30% of cases pain is accompanied by sensory and motor deficits caused by compression of the nerve root (Eysel et al., 1992). The estimated annual incidence of LRS in Western countries is 0.5% (Cherkin et al., 1994; Younes et al., 2006), mainly manifested in midlife, between ages 30-50. While symptoms usually resolve spontaneously or with conservative treatment, 20-30% of patients continue to experience disability and pain for more than one year (Weber et al., 1993; Vroomen et al., 2000; Peul et al., 2007). Dutch multidisciplinary guidelines (Health Council of the Netherlands, 1999) recommend surgery to remove the extended disc material if symptoms do not improve after 6 weeks.

These guidelines also recommend that, if surgery is performed, patients should receive postoperative physiotherapy treatment focusing on four main treatment goals: 1. improving neuromusculoskeletal and movement-related functions; 2. improving activities and participation; 3. reduce pain; and 4. educating and advising patients about, for example, pathology or dealing with postoperative pain. However, depending on the outcome measure utilized in the study, about 20-50 % of patients who are operated for LRS continue to experience disability, pain, and loss of work capacity in the long term after surgery (Korres et al., 1992; Junge et al., 1995; Schade et al., 1999). Since most of the direct and indirect costs of surgery for LRS can be attributed to these group of patients, an important aim of postoperative treatment is to prevent patients from residual disability, pain and loss of work capacity after surgery for LRS.

In the past decade, a number of clinical screening instruments have been developed to identify patients at risk of future disability, pain, and loss of work capacity in patients with non-specific low back pain (i.e. back pain without a specific pathological or anatomical explanation) (Linton et al., 2003; Hilfiker et al., 2007; Jellema et al., 2007). However, there is a lack of brief clinical screening instruments to predict outcome in patients with LRS. Hilficker et al. (2007) concluded from a review of 16 studies about clinical screening instruments for patients with non-specific low back pain that these instruments should contain prognostic factors from four domains of demographic, clinical, cognitive behavioural and work related factors. With regard to the empirical evidence for risk factors that might give direction to treatment of patients with non-specific low back pain there seems to be relatively clear evidence that different cognitive behavioural factors and work-related factors predict future disability, pain, and work capacity (Linton et al., 2000; Vlaeyen & Linton, 2000; Pincus et al., 2002; Crook et al., 2002). However, most of the studies were cross-sectional in nature and the relative contribution of the different pain-related cognitive behavioural factors has not yet been compared in prospective studies in both patients with non-specific low back pain and patients with LRS. There have been also no systematic reviews of variables associated with an unfavourable outcome after surgery in patients with LRS.

The main goal of the present thesis was to identify at an early postoperative stage risk factors of an unfavourable functional outcome of disability, pain and loss of work capacity at 6 weeks and 6 months after surgery for LRS, and to develop a screening tool to identify patients at risk of residual complaints at 6 months follow-up. We focus on factors that possibly give direction to postoperative treatment which would enable us to better match treatment with patient characteristics: cognitive behavioural factors fear of movement/(re)injury, passive pain coping and outcome expectancies and work related factors physical work load and job satisfaction. Additionally, to get more insight in the current treatment after surgery for LRS, we exploratively examined postoperative physiotherapy treatment characteristics and disability and pain at 6 monthts after surgery for LRS.

The role of cognitive behavioural and work-related factors in patients with low back pain

Since the introduction of the gate control theory of Melzack and Wall (1965) it is widely accepted that sensory, affective, and cognitive dimensions are involved in pain experience, which means that pain is not only a product of information ascending from peripheral sources to the brain but also of information descending from the brain. A decade later, Fordyce (1982) was one of the first to apply the principles of operant conditioning to the treatment of chronic pain, and postulated that pain behaviour could be an important focus of treatment. Essential to this postulate was the assumption that factors maintaining pain are not necessarily the same as those initiating pain. Fear avoidance models further illustrate how acute back pain can develop into chronic pain (Philips et al., 1987; Linton et al., 1995) as a result of several interacting cognitions, including fear of pain, worrying and catastrophic thinking and avoidance of activity including resting and retreating.

An important construct of the model that has attracted growing attention is fear of movement/(re)injury (Kori et al., 1990), which refers to an excessive, irrational, and debilitating fear of physical movement and activity because of a feeling of vulnerability to painful injury or re-injury, and which may result in the avoidance of various activities. In the long term, avoidance behaviour results in a reduction of both physical and psychosocial activities and in increased disability (Waddel et al., 1993; Vlaeyen et al., 1995; Linton & Buer, 1995; Crombez et al., 1998) and may cause detrimental changes in the musculoskeletal and cardiovascular systems, which is often referred to as 'disuse syndrome' (Bortz et al., 1984). In addition to pain related fear of movement/(re)injury and passive pain coping (avoidance behaviour and catastrophizing), the role of outcome expectancies has gained increased attention in the area of chronic back pain. Theories holds that positive expectancies of outcome can directly affect the outcome, for example, by resulting in higher levels of perceived control, less catastrophizing and more positive interpretation of the pain, which in turn might result in less severe pain outcomes or disability (Mondloch et al., 2001; Goossens et al., 2005), specifically in possibly highly effective interventions such as surgery for LRS. In the past decades the mechanisms of the cognitive behavioural factors pain related fear of movement/(re)injury, passive pain coping and negative outcome expectancies have been supported by numerous investigations establishing the predictive role of these factors for future outcome in patients with LRS and non-specific low back pain (Linton et al., 2000; Vlaeyen & Linton, 2000; Pincus et al., 2002).

In addition, physical and psychological related factors directly related to work have been supposed to predict future work capacity in patients with non-specific low back pain (Crook et al., 2002). Specifically, a higher physical workload, which directly affects the biomechanical load through posture, movement, and exerted forces, possibly leading to mechanically provoked pain, has been shown to predict future loss of work capacity (Wickström & Pentti, 1998; Elders et al., 2003). Moreover, psychosocial work-related factors have been shown to affect return to work. Specifically, a lack of job satisfaction is assumed to be a major additional barrier to the resumption of professional activities (van der Giezen et al., 2000; Tubach et al., 2002; Shaw et al., 2006), with patients who are less satisfied with their job being less motivated to return to work.

Outline of this thesis

The main goal of the present thesis was to identify at an early stage risk factors of an unfavourable functional outcome of disability, pain and loss of work capacity at 6 weeks and 6 months after surgery for LRS, and to develop a screening tool to identify patients at risk of residual complaints at 6 months follow-up. We first carried out a systematic review to summarize evidence concerning the predictive value of risk factors in patients undergoing surgery for LRS caused by a herniated lumbar disc (Chapter 2). We then performed a prospective cohort study in which we included all patients undergoing surgery for LRS in a 2 year period. We focussed on particularly cognitive behavioural and work related factors, which might give direction to postoperative treatment and would enable us to better match treatment with patient characteristics (Chapter 3-4). Additionally, we developed a screening instrument to identify patients at risk of residual complaints after surgery for LRS (Chapter 5). Finally we exploratively examined the association between postoperative physiotherapy treatment characteristics and the outcome disability and pain at 6 months after surgery for LRS (Chapter 6).

Systematic review

Chapter 2 describes a systematic review which summarizes the evidence concerning the predictive value of risk factors in patients undergoing surgery for LRS caused by a herniated lumbar disc, as confirmed by neuroradiological assessment or by operative findings. The electronic databases Medline, Psycinfo, CHINAL and Embase were searched for articles written in English, Dutch, and German. Because operation techniques, radiological diagnostics, and indications for surgery have changed in the past decades, we excluded studies initiated before 1980. To be sure not to exclude any relevant studies, we adopted a sensitive search strategy.

Prospective cohort study examining patient related risk factors

We included all consecutive patients undergoing surgery for LRS at one of the four participating Dutch hospitals over a two year period. Patients completed clinical tests and self-reported measures one day preoperatively, 3 days postoperatively and outcome questionnaires 6 weeks and 6 months postoperatively (Figure 1).

In Chapter 3 we describe the results of a study that examined the predictive value of cognitive behavioural factors on both outcome measures disability and pain at 6 weeks and 6 months follow-up. We studied the predictive value of pain-related fear of movement/(re)injury,

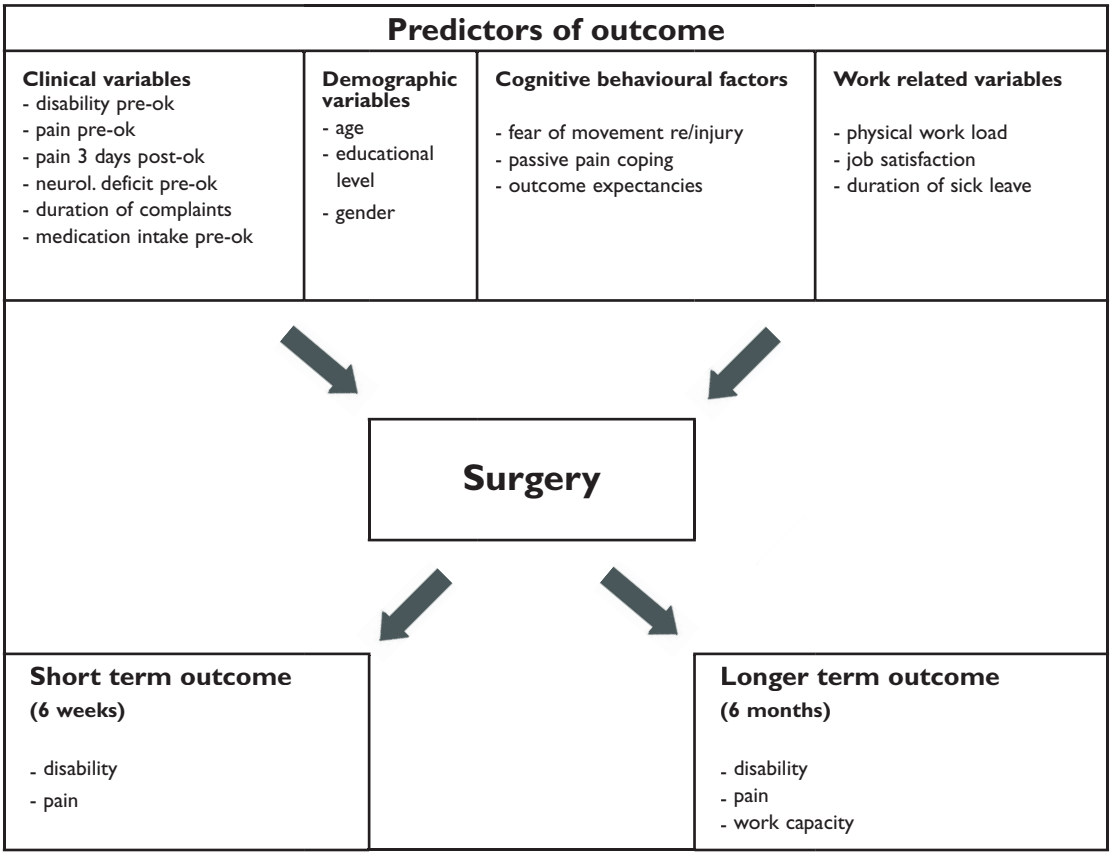

Figure 1. Predictors of the short and longer term outcome after surgery for LRS

passive pain coping and negative outcome expectancies at baseline, taking into account the role of demographic (age, gender, educational level) and clinical variables (preoperatively measured pain, disability, neurological deficits, medication intake, history of complaints and pain 3 days postoperatively).

In Chapter 4 we describe the results of a study that examined the role of both cognitive behavioural and work-related factors on the outcome work capacity at 6 months after surgery in the subgroup of patients in paid employment before surgery. We studied the predictive value of pain-related fear of movement/(re)injury, passive pain coping, negative outcome expectancies, physical work load, job satisfaction and duration of sick leave, taking into account the role of demographic and clinical variables.

In Chapter 5 we describe the development of a brief screening instrument to identify patients at risk of residual complaints after surgery for LRS. Clinical, demographic, and cognitive behavioural factors were studied to derive a clinical screening instrument to predict an overall outcome measure including disability, pain and work capacity.

Postoperative physiotherapy treatment characteristics
In Chapter 6 we describe the results of the study examining postoperative physiotherapy treatment characteristics. We exploratively examined the association between the treatment time physiotherapists spent on the main treatment goals, the sub-goals physiotherapists chose to achieve these main goals, the number of treatment sessions, physiotherapist characteristics and the outcome disability and pain at 6 months follow-up. In addition we studied the association between the preoperatively measured patient related levels of fear of movement/(re)injury and passive pain coping and the choice of the treatment sub-goal to reduce these factors at the start of the postoperative treatment.

Summary of the main results
Chapter 7 gives a summary of the main results of these studies.

General discussion
Chapter 8 presents an integrated overview of the main findings of these studies. The outcome of surgery is discussed first, followed by the variables that predict this outcome, the development of a screening instrument, postoperative physiotherapy treatment characteristics and, methodological considerations. Finally, the general discussion will end with clinical implications, suggestions for future research and conclusions.

CHAPTER 2

A systematic review of bio-psychosocial risk factors for an unfavourable outcome after lumbar disc surgery

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Jasper J. den Boer, Rob A. B. Oostendorp, Tjemme Beems, Marten Munneke, Margreet Oerlemans, Andrea W. M. Evers. A systematic review of bio-psychosocial risk factors for an unfavourable outcome after lumbar disc surgery. Eur Spine J (2006) 15: 527–536

Abstract

The objective of this systematic review is to summarize scientific evidence concerning the predictive value of bio-psychosocial risk factors with regard to the outcome after lumbar disc surgery. Medical and psychological databases were used to locate potentially relevant articles, which resulted in the selection of eleven studies. Each of these studies has a prospective design that examined the predictive value of preoperative variables for the outcome of lumbar disc surgery. Results indicated that socio-demographic, clinical, work-related as well as psychological factors predict lumbar disc surgery outcome. Findings showed relatively consistently that a lower level of education, a higher level of preoperative pain, less work satisfaction, a longer duration of sick leave and more passive avoidance coping function as predictors of an unfavourable outcome in terms of pain, disability, work capacity, or a combination of these outcome measures. The results of this review provide preliminary opportunities to select patients at risk for an unfavourable outcome. However, further systematic and methodologically high quality research is required, particularly for those predictors that can be positively influenced by multidisciplinary interventions.

Keywords: Lumbar disc surgery, Predictor, Prospective, Bio-psychosocial, Review

In 1934, Mixter and Barr described the close pathomorphological relation between radiation of pain in the leg and lumbar disc herniation. By removing the lumbar disc material that compromised a lumbar nerve root, it was possible to relieve specific neuropathic symptoms such as segmental irradiating pain in the leg, sensory loss, and motor disturbance. Internationally, this method is the most accepted and applied treatment for persistent pain caused by lumbar disc herniation, which is not relieved by conservative treatment (Cherkin et al.,1994; Gibson et al., 1999). In the Netherlands 0.5% of the population develop a lumbosacral radiculair syndrome (LRS) on an annual basis (Coskun et al., 2000). Although the majority of patients obtain functional recovery without treatment or with conservative treatment (Vroomen et al., 2000; Ito et al., 2001), 20% of the patients require an operation (Vroomen et al., 2000; Weber et al., 2003). Research on the results of lumbar disc surgery shows that success rates for the long-term outcome vary between 60–90%, depending upon which outcome measure was utilized (Spangfort, 1972; Korres et al., 1992; Findlay et al., 1998; Loupasis et al., 1999; Yorimitsu et al., 2001). Major complaints after surgery are back or leg pain, restriction in daily activities and loss of work capacity; i.e., the inability to work. In an attempt to predict the individual differences in the outcome of lumbar disc surgery, various prospective cohort studies investigated differing predictors for an unfavourable outcome, including socio-demographic, clinical, work related, and psychological variables. However, till now, the scientific evidence of the predictive value of different prognostic factors has not been summarised and structured through a systematic overview. By constructing such a review, this study aims to provide an insight into the most relevant prognostic factors that could contribute to the identification and selection of patients at risk, as well as the development of tailored postoperative treatment methods based on the prognostic factors.

Methods

Electronic database searches of Medline, Psychinfo, CHINAL and Embase were performed for articles written in English, Dutch and German (1980–2003). To ensure that we did not exclude any relevant studies, we adopted a sensitive search strategy using the following combination of key words: lumbar, disc, herniation with surgery, discectomy or laminectomy and with prognostic, predict, risk factor, longitudinal or prospective. These extensive searches lead to 256 references. Based upon the abstracts, studies were excluded because: (1) the data was collected retrospectively; (2) the goal of the studies was different from studying predictors for the outcome after LRS (e.g, the effect of different surgery techniques, rehabilitation programs, medication intake or non-operative treatment in comparison with operative treatment); 3. specific patient groups were examined (adolescents, patients above 70 years old, patients with rheumatoid arthritis, patients with spondylolistesis). Because operation techniques, radiological diagnostics and indications for surgery have changed in the past decades, we also decided to exclude studies initiated prior to 1980. The exclusion of citation based upon the abstract lead to a pre-selection of 22 articles. The references of all selected articles were screened for additional potentially eligible publications, further producing seven articles. The final selection of the studies was based on the following criteria:

* Involvement of a population which had undergone surgery for a lumbar herniated disc. Study designs, which included patients operated for lumbar stenosis or patients that had undergone a lumbar fusion were excluded.
* The complaints had to be based on the neuropathic symptoms caused by a herniated lumbar disc and had to be confirmed by neuroradiological assessment (MRI, CT, myelography or rhizography) or by operative findings (bulging/protrusion, prolaps and sequester).
* The design of the study had to be a prospective cohort study (considered the appropriate method for best evidence concerning prognosis (Sackett et al., 1997).
* The aim of the study was to detect predictors for pain, disability, work capacity, or a composite score.
* Inclusion of the patients had had to occur within 6 weeks prior to the date of surgery.
* The sample size at first assessment had to exceed 30 patients.
* The publication had to be a full report, letters and abstracts being excluded.

Two reviewers screened the selected studies independently. All disagreements between the reviewers were subsequently discussed during a consensus meeting. A third reviewer was consulted to achieve a final decision in the case of disagreement. The review team exists of a multidisciplinary team of researchers with a great deal of experience in the research and clinical field of chronic pain (i.e. Dr. A.W.M. Evers, psychologist, Dr. M. Munneke, physical therapist and epidemiologist and J. den Boer, Msc, research physical therapist). Totally 14 studies were excluded because (1) they included a mixed population of patients following surgery for a herniated disc, lumbar stenosis and a lumbar fusion (Dzioba et al., 1984; Waddel et al., 1988; Jonssen, 1993), (2) only a selection of patients were operated (Weber, 1983; Hasenbring et al., 1994) or patients had undergone more than one back operation (Abramovitz et al., 1991), (3) the aim of the study was to predict solely the operative or radiological findings (Spengler et al.,1990; Vucetic et al., 1997; Vucetic et al., 1999; Porchet et al., 2002) or the diagnosis was not confirmed by radiological findings (Kosteljanetz et al., 1984[a]; Kosteljanetz et al., 1984[b]; Lutz et al., 1999), (4) the follow-up time was less than one week (Groot et al., 1996) or varied largely between patients with differences more than one year (Rompe et al., 1999; Asch et al., 2002), or (5) the study included less than 30 patients (Coskun et al., 2000). Finally, 15 publications were selected (Rosenstiel & Gross, 1986; Sørensen et al., 1987; Hurme & Alaranta, 1987; Graver et al., 1992-1999; Dauch et al., 1994; Fulde et al., 1995; Junge et al., 1995; Kjellby-Wendt et al., 1995; Donceel et al., 1999; Schade et al., 1999; Woertgen et al., 1999;). Four publications (Graver et al., 1992; Graver et al., 1995; Graver et al., 1998; Graver et al., 1999) were based upon the findings from the same sample, and therefore we regard these publications as one study, resulting in the inclusion of 11 studies. All studies except one included patients before surgery. One study included patients shortly after surgery (6 weeks postoperatively). From the latter study, only those factors that are not affected by the assessment point (before and after surgery) were included.

For these 11 studies, predictor variables were reported only when (1) the operationalisation and statistical results of significance (P-value, correlations) were sufficiently described in the text and; (2) when the variables were measured in at least two studies (this because of the large number of predictor variables, i.e. approximately 150).

Predictor variables were categorised into sociodemographic, clinical, work-related, and psychological variables. The first category, socio-demographic predictor variables, consists of the items gender, age, body weight, body length, education level and marital status. Clinical predictors used in the studies, we looked at consist of two main categories, namely pre-operative status (including pre-operative pain and disability, other complaints and duration of complaints) and clinical signs (including segmental sensory loss, straight leg raising test, radiological findings and operative findings). Work-related predictor variables entail a patient's physical work conditions, work satisfaction and duration of sick leave. Psychological predictors measured in the studies were depression, anxiety, somatisation, coping strategies, life events and social support.

As a result of the relatively small number of selected studies, the wide variation between them in terms of study design, predictor variables, outcome measures and statistical analyses as well as the lack of a widely accepted quality rating system for prospective studies (Linton, 2000), the methodological quality of the studies was not rated. The heterogeneity of the prognostic factors and outcome measures also precluded the statistical pooling of the results. Instead, to be sure of the basic methodological quality of the studies, relatively stringent selection criteria were formulated. These criteria were based on the frequency with which a variable was measured in different studies, and whether a significant association between this variable and the outcome was established. This resulted in the following categories for the level of evidence

Positive evidence

The number of studies which found a significant association between predictor variables and surgery outcome exceeds the number of studies with no significant association by three or more.

Preliminary positive evidence

The number of studies with a significant association exceeds the number of studies with no significant association by two.

Conflicting evidence

1. The number of studies with a significant association exceeds the number of studies with no significant association by one or less.
2. The number of studies with no significant association exceeds the number of studies with a significant association by one.

Preliminary negative evidence

The number of studies with no significant association between predictors and outcome exceeds the number of studies with a significant association by two.

Negative evidence

The number of studies with no significant association exceeds the number of studies with a significant association by three or more.

Table 1 Prospective studies of prognostic factors for the outcome after lumbar disc surgery

Studies	First Assessment	Follow-up	Outcome Variables	Significant predictors *	Comments:
Dauch et al 1994	1 day before surgery N = 109 Age = 18-66 (M= 42) Gender = 44% female	6 months after surgery N=105	pain. disability. work capacity	**Socio-demographic**: age **Clinical**: duration of complaints, other preoperative complaints **Work**: duration of sick leave	- use of additional out come measure (segmental motor loss) - no multivariate statistics
Donceel & Du Bois 1999	6 weeks after surgery N = 177 Age = 18-69 (M= 39) Gender = 36 % female	1 year after surgery N = 175	work capacity	**Socio-demographic**: gender, education level **Clinical**: segmental sensory loss **Work**: duration of sick leave **Psychological**: depression, somatisation, coping, life events	- one outcome measure, work capacity - exclusion of self employed workers and patients with age > 65 - no pre-operative assessment - no multivariate statistics
Fulde et al 1995	Between admission to hospital and surgery N = 52 Age = 16-62 (M= 41) Gender = 46% female	6 months after surgery N = 48	composite score consisting of pain, work capacity and doctor visit	**Psychological**: personality characteristics	- use of only one outcome measure (composite score) - N < 50 at follow up
Graver et al 1992	Before surgery N = 122Age = 18-66 (M= 41)Gender = 46% female	1 year after surgery N = 122	composite score consisting of pain, disability, clinical examination and medication	**Clinical**: fibronilytical hyperactivity	- use of only one outcome measure (composite score
Graver et al 1995			pain. disability. composite score consisting of pain, disability, clinical examination and medication	**Psychological**: anxiety, somatisation, coping strategies	- use of additional outcome measure: (use of analgesics)
Graver et al 1998			composite score consisting of pain, disability, clinical examination and medication. work capacity	**Socio-demographic**: gender, body weight, body length **Work:** work conditions (physical), duration of sick leave	
Graver et al 1999		7 years after surgery N = 114	pain. composite score consisting of pain, disability, clinical examination and medication	**Socio-demographic**: gender **Clinical:** fibronilytical hyperactivity, operative findings **Psychological:** somatisation	
Hurme & Alaranta 1985	1-4 weeks before surgeryN = 220Age = 16-54 (M= 39)Gender = 46 % female	6 months after surgery N=215	pain disability. composite score consisting of pain and work capacity	**Socio-demographic**: age, body weight, education level, marital status **Clinical**: preoperative pain and disability, duration of complaints **Work**: work conditions (physical), work satisfaction **Psychological:** somatisation	- exclusion of patients with age > 55

Table 1 (continued)
Prospective studies of prognostic factors for the outcome after lumbar disc surgery

Studies	First Assessment	Follow-up	Outcome Variables	Significant predictors *	Comments:
Junge et al 1995	Between admission to hospital and surgery N = 381 Age = 18-69 (M= 45) Gender = 40% female	1 year after surgery N= 328	composite score consisting of pain, work capacity and doctor visit	**Socio-demographic**: education level **Clinical**: preoperative pain and disability, duration of complaints, other complaints, radiological findings **Work**: work satisfaction, duration of sick leave **Psychological:** coping	- use of only one outcome measure (composite score) exclusion of patients with age > 55- - no multivariate statistics
Kjellby et al 1999	Before surgeryN = 50 Age = 21-68 (M= 40) Gender = 28% female	2 years-after surgery N = 47	composite score consisting of pain and patient's opinion	**Clinical**: preoperative pain **Psychological:** depression, anxiety	- use of only one outcome measure (patients opinion) N < 50 at follow-up no multivariate analyses
Rosen stiel & Gross 1986	1 day before surgery N = 50 Age = 18-66 (M= 42) Gender = 44% female	6 weeks after surgery N = 47	pain, composite score consisting pain and patients opinion	**Clinical**: operative findings Psychological: coping	-N < 50 at follow-up - use of two additional outcome measures (sleep disturbance and depression)
Schade et al 1999	Before surgeryN = 46 Age = 20-50 Gender = 26% female	2 years after surgery N = 42 (91%)	pain, disability,. work capacity, composite score consisting pain, disability, work and medication	**Clinical**: preoperative pain and disability,radiological findings **Work**: work satisfaction **Psychological:** depression, anxiety, coping, social support	- exclusion of non employed patients and patients with age > 50 - -N < 50 at follow up
Sørensen et al 1987	Before surgery N = 57 Age = not described Gender = 49% female	6 months after surgery N= 49	composite score consisting of pain and patient's opinion	**Socio-demographic:** gender **Clinical:** preoperative pain, duration of complaints **Work**: duration of sick leave **Psychological:** depression, anxiety, somatisation	- use of only one outcome measure (composite score) -N < 50 at follow up - no multivariate analyses
Woertgen et al 1999a	Before surgery. N = 121 Age = 15-70 (M= 43) Gender = 30% female	1 year after surgery N= 98	composite score consisting of pain, disability, work capacity, medical consumption	**Socio-demographic:** level of education **Clinical**: straight leg raising	- use of only one outcome measure (composite score)
Woertgen et al 1999b	28 months after surgeryN=98			**Clinical**: segmental sensor loss, straight leg raising test	

* Predictors are significant for at least one outcome variable of pain, disability, work, patient opinion or composite score.

In order to compare the results of the studies, we collectively analysed the predictors for all outcome measures (pain, disability, work capacity and composite score). Subsequently, we separately examined the extent to which the predictor variables were able to predict different outcomes. Because the criteria for the composite scores differed greatly between the different studies (including a combination in the outcomes of pain, disability, work capacity, doctor visits, medical consumption, sleep disturbances, patient's opinion or clinical examination), it was not possible to separately analyse these outcomes. Due to the small number of studies with single outcome parameters of pain, disability or work capacity, no level of evidence was defined in these analyses.

Results

Table 1 displays a summary of information about the reviewed studies, including population, research design and results. All studies included more than 50 patients at first assessment, and five studies included more than 100 patients (Hurme & Alaranta, 1987; Graver et al., 1992-1999; Dauch et al., 1994; Junge et al., 1995; Donceel et al., 1999). In all studies except one (Donceel et al., 1999), the inclusion of patients took place within a week before surgery. Dropout rates in all studies were generally low with the exception of three studies (Sørensen et al., 1987; Junge et al., 1995; Woertgen et al., 1999) that had a follow-up loss of more than 10%. All studies except one (Rosenstiel & Gross, 1986) used a follow-up time of more than 6 months, with four studies including patients who had received followup investigations over one year after surgery (Kjellby-Wendt et al., 1995; Graver et al., 1992-1999; Schade et al., 1999; Woertgen et al., 1999). In addition, two studies (Graver et al., 1999; Woertgen et al., 1999) had more than one follow-up assessment. In regard to the statistical analyses used by the different studies, six studies used multivariate regression analyses (Rosenstiel & Gross, 1986; Hurme & Alaranta, 1987; Graver et al., 1992-1999; Fulde et al., 1995; Schade et al., 1999; Woertgen et al., 1999), while five studies performed univariate analyses (Sørensen et al., 1987, Dauch et al., 1994; Junge et al., 1995; Kjellby-Wendt et al., 1995; Donceel et al., 1999).

Table 2 gives an overview of the predictors for all outcome measures, and indicates whether or not these predictors are significant, as well as delineating their level of evidence. All main categories; i.e. socio-demographic, clinical, work-related, and psychological factors, contained at least one variable that was classified as positive evidence. In regard to socio-demographic variables, positive evidence was found for a lower level of education. In the category clinical variables, higher levels of preoperative pain were significantly predictive in terms of positive evidence, while in terms of work-related variables, less work satisfaction and a longer duration of sick leave were predictors for an unfavourable outcome. Regarding psychological variables, three predictors with positive evidence were found: anxiety, somatisation, and passive avoidance coping. In contrast to anxiety and somatisation, which were both measured by relatively corresponding scales, the assessment of coping strategies differed in that various cognitive and behavioural coping strategies were either measured in regard to stress or pain, or by assessing pain behaviour. Irrespective of these varying assessment methods, there was a tendency towards the fact that passive avoidance coping strategies relatively consistently predicted an unfavourable outcome in three (Graver et al., 1992-1999; Fulde et al., 1995; Donceel et al., 1999) of the five studies.

Table 2 Overview of significant predictors for at least one outcome measure (pain, disability, work capacity and composite score)

Predictor	Outcome (pain, disability,work and composite score) significant	not significant	positive findings/ n study (%)	level of evidence
Socio-demographic				
Gender (female)	B, D, J	A, F, K, I	3/7 (42.8%)	3
Age	A, E	B, K, D, I, F, J	2/8 (25%)	5
Body weight	D, E	B*, I	2/4 (50%)	3
Body length	D	B*, I	1/3 (33%)	3
Education level	E, B, F, L, K	J	5/6 (84%)	1
Marital status	E	J, I, B	1/4 (25%)	4
Clinical				
Preoperative pain	E, F, G, I, J	A, H	5/7 (71.4%)	1
Preoperative disability	E, F, I	H	3/4 (75%)	2
Other preoperative complaints	A, F		2/2 (100%)	2
Duration of complaints	A, E, I, J, F	D, B, K	5/8 (62.5%)	2
Clinical signs				
Segmental sensory loss	B, K		2/2 (100%)	2
Straight leg raising test	K	E, F, I	1/4 (25%)	4
Radiological findings	F, I		2/2 (100%)	2
Operative findings	D, H	E	2/3 (66.6%)	3
Work				
Work conditions (physical)	D, E	B, J	2/4 (50%)	2
Work satisfaction	E, I, F		3/3 (100%)	1
Duration of sick leave	A, B, D, F, J	I, K	5/7 (71.4%)	1
Psychological				
Depression	G, I, J	C, D, E, F	3/7 (42%)	3
Anxiety	D, G, I, J	E	4/5 (80%)	1
Somatisation	D, E, J	H	3/4 (75%)	1
Coping	C, D, F, H		4/4 (100%)	1
Live events	B	J	1/2 (50%)	3
Social support	I	J	1/2 (50%)	3

A = Dauch et al. (1994)
B = Donceel & Du Bois (1999)
C = Fulde et al. (1995)
D = Graver et al. (1992)
E = Hurme and Alaranta (1987)
F = Junge et al. (1995)
G = Kjelby et al. (1999)
H = Rosenstiel and Gross (1986)
I = Schade et al. (1999)
J = Sørensen et al. (1987)
K = Woertgen et al. (1999)
*Trend (P < 0.1)

Level of evidence:
1 = Positive evidence
2 = Preliminary positive evidence
3 = Conflicting evidence
4 = Preliminary negative evidence
5 = Negative evidence

Preliminary positive evidence was further found in both clinical and work-related variables. In regard to the former, high levels of preoperative disability, other preoperative complaints, a longer duration of complaints and segmental sensory loss were classified as preliminary positive evidence. Additionally, radiological findings (especially the type of disc herniation) were significantly associated with the outcome of surgery, which indicates that a bulging or protruded disc predict an unfavourable outcome (Junge et al., 1995; Schade et al., 1999). In terms of the work-related variables, preliminary positive evidence was found for a patient's physical work condition.

Conversely, the studies examined here consistently found that a number of predictors did not affect the outcome after lumbar disc surgery. Preliminary negative evidence was found for the socio-demographic variable marital status as well as the clinical variable straight leg raising.

Moreover, negative evidence was found for the socio-demographic variables age and smoking. In fact, smoking was the only variable that showed a consistently negative association with all three outcomes in more than one study (Schade et al., 1999; Woertgen et al., 1999).

Table 3 shows an overview of the predictors for the outcomes of pain, disability and work capacity. The first outcome, pain, was measured in five studies (Rosenstiel & Gross, 1986; Hurme & Alaranta, 1987; Dauch et al., 1994; Graver et al., 1995; Graver et al., 1999; Schade et al., 1999) through the use of validated pain scales. Three studies (Rosenstiel & Gross, 1986, Dauch et al., 1994; Graver et al., 1995-1999) used the VAS (Price et al., 1983), one study the Pain Index (Hurme & Alaranta, 1987), and one study (Schade et al., 1999) used a composite score of the VAS and the McGill Pain Questionnaire (Melzack R, 1975). Variables that most consistently predicted pain were the operative findings (significant in two out of three studies) and coping (consistently significant in two studies). Disability was measured in four studies (Dauch et al., 1994; Graver et al., 1995-1999; Lutz et al., 1999; Schade et al., 1999) using the validated disability scales for lower back pain: the Disability index (Hurme & Alaranta, 1987) and the Roland disability scale (Roland & Morris, 1983). Variables that best predicted disability were preoperative disability, less work satisfaction, and somatisation (all were consistently significant in two studies). Work capacity was measured in four different studies (Dauch et al., 1994; Graver et al., 1998; Donceel et al., 1999; Schade et al., 1999) by assessing the difference in the number of paid working hours before the operation and during the follow-up assessment. The variable that best predicted work capacity was depression (consistently significant in two studies).

Table 3 Overview of predictors for the outcome pain, disability and work capacity separately*

Predictor	Pain		Disability		Work capacity	
	sign	not sign	sign	not sign	sign	not sign
Socio-demographic						
Gender (female)	D	A, I		A,I	B, D	A, I
Age	A	E, I	E	A,I	A	B, I
Body length						B, D, I
Body weight	E, I		E	I	D	B, I
Marital status	E	I		E,I		B, I
Clinical						
Preoperative pain	E, I	A, H		A,E,I	I	A
Preoperative disability		E, H, I	E, I			
Duration of complaints	A	E, I	E	A,I	I	A, B, D
Straight leg raising test		E, I				
Operative findings	D, H	E		E,I		
Work						
Work conditions (physical)					D	B
Work satisfaction	E	I	E, I			
Duration of sick leave	A	I		A,I	B, D	A, I
Psychological						
Depression	I	D, E	I	D,E	D	
Anxiety	D	E, I	D	E,I		
Somatisation	D	E, H	D, E			
Coping	D, H			D,I		I

A = Dauch et al. (1994) B = Donceel & Dubois (1999) D = Graver et al. (1992)
E = Hurme & Alaranta (1987) H = Rosenstiel & Gross (1986) I = Schade et al. (1999)

* The following predictors were not measured in relation to pain, disability or work capacity separately: educational level, other preoperative complaints, segmental sensor loss, radiolological findings, life events, social support.

Discussion

Results of this systematic review indicate that the outcome after lumbar disc surgery is determined by a multiple set of bio-psychosocial variables. Preliminary evidence indicates that a lower level of education, a higher level of preoperative pain, less work satisfaction, a longer duration of sick leave, passive avoidance coping strategies and higher levels of anxiety and somatisation relatively consistently predicted an unfavourable outcome after lumbar disc surgery in terms of pain, disability, work capacity, or a composite score.

Because of its findings, this study offers preliminary opportunities to select patients at risk for an unfavourable outcome and will be useful in developing tailored treatment after operation. However, due to the differences in predictor variables and outcome assessments, as well as the methodological shortcomings of the studies, more systematic research is required regarding specific prognostic factors for specific outcomes.

When considering the socio-demographic variables, positive evidence was found that a lower level of education predicts an unfavourable outcome. This is in line with the findings of the research conducted among other chronic pain populations, proving that a lower social economic status is a risk factor for various chronic pain conditions (Frymorer, 1992; Hildebrandt et al., 1997; Evers et al., 2003). The specific nature of this relationship is not entirely clear though, and could be caused by various factors, such as physical work conditions, less access to health services, and/or less healthy behaviours (Evers et al., 2003). In contrast, all other socio-demographic variables (gender, age, body length, body weight and marital status) showed only conflicting or negative evidence in regard to the outcome after lumbar disc surgery. For instance, although younger patients have frequently been assumed to recover more quickly following lumbar disc surgery (due to a better physical condition), six of eight studies were unable to find a significant association between age and the follow-up outcome.

In regard to the clinical predictors, there is either positive or preliminary positive evidence for the variables pre-operative pain and disability, other complaints, and duration of pain, indicating that the severity and duration of complaints prior to surgery predict an unfavourable outcome. In addition, the loss of the neurological function "segmental sensory" was predictive for the outcome after lumbar disc surgery. Recent studies suggest that this segmental sensory loss could be a reflection of disturbances of sensory input in the central nervous system which lead to hypersensitivity for pain through a sensitisation of the dorsal horn (central neuro-plasticity) (Hanai et al., 1996; Woolf & Costigan 1999; Wilder-Smith et al., 2002; Hou et al., 2003).

Regarding the work-related variables, the duration of sick leave was a consistent predictor, suggesting that a long pain history accompanied by (partial) disability and work difficulties, has unfavourable effects on the outcome of lumbar disc surgery. In line with studies conducted among chronic pain populations (Croft et al., 1996; Gallagher et al., 1998; Weide et al., 1999; van der Giezen et al., 2000) our review also found positive evidence that a lack of work satisfaction functions as a predictor for an unfavourable outcome, suggesting that psychosocial aspects of work are important for the outcome of the surgery thus requiring further research.

Finally, regarding the psychological variables, positive evidence was found for anxiety, somatisation and passive avoidance coping strategies. The predictive value of anxiety and somatisation is in accordance with previous research (Main et al., 1992; Linton, 2000; Pincus et al.,

2002), revealing that higher levels of physical and psychological complaints are predictive for an unfavourable outcome in various chronic pain populations. Furthermore, the role of passive avoidance coping strategies as a risk factor also corresponds to the research findings in other pain populations (Morley & Williams, 1990; van Tulder et al., 2001; Evers et al., 2002). Consequently, multidisciplinary treatment options that focus on passive avoidance coping and have been successfully applied in chronic pain population, could also be effective in enhancing the recovery of risk patients after lumbar disc surgery.

Although all the studies were prospective, and the inclusion of the articles was based on strict selection criteria, results have to be interpreted with caution and it is imperative that several methodological shortcomings of the studies are mentioned. This study is based on few trials with relatively small patient samples. An overestimation of the true effects of predictors can therefore not be excluded. The majority of the studies used a composite score as outcome measure and did not present the results for specific outcomes. As a result, findings of predictors for separate outcomes seem to be largely determined by the limited number of predictors used in these studies, which implies that more systematic research of specific predictors for different outcomes of pain, disability and work capacity is required. In addition, no study controlled for pain medication or postoperative treatment (e.g. physical therapy). Predictor assessments also vary widely between studies, especially for work-related variables and coping strategies. Statistical methods used in the studies were frequently univariate and only one study (Schade et al., 1999) took the preoperative level of pain and disability into account in multivariate analyses. Because of these and other methodological shortcomings of the studies, it was not possible to either evaluate the methodological quality of the studies using a proper rating scale, or to statistically pool the results of the studies. Instead, comprehensive selection criteria for the studies of this review and a preliminary, best possible definition of the level of evidence were used. Future research requires more systematic and methodologically sound studies for the prediction of the outcome of lumbar disc surgery.

Conclusion

This review has found an evidence that socio-demographic, clinical, work-related, and psychological factors function as predictors for the outcome after lumbar disc surgery. The results of this review provide opportunities to select those patients that are at risk for an unfavourable outcome and who may benefit from multidisciplinary treatment after lumbar disc surgery. However, in order to develop tailored intervention after lumbar disc surgery for patients at risk, further systematic and methodologically high quality research is required, particularly for those predictors that can be positively influenced by specific (multidisciplinary) interventions.

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CHAPTER 3

Continued disability and pain after lumbar disc surgery: The role of cognitive-behavioral factors

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Abstract

Cognitive-behavioral factors are considered important in the development of chronic disability and pain in patients with low back pain. In a prospective cohort study of 277 patients undergoing surgery for lumbosacral radicular syndrome, the predictive value of preoperatively measured cognitive-behavioral factors (fear of movement/(re)injury, passive pain coping, and negative outcome expectancies) for disability and pain intensity at 6 weeks and 6 months after surgery was investigated, taking into account the effect of possible confounding variables. Higher levels of cognitive-behavioral factors were found to be associated with a worse outcome at both 6 weeks and 6 months. These associations remained significant after controlling for possible confounding variables (preoperative disability and pain intensity, age, gender, educational level, duration of complaints, neurological deficits, and intake of analgesics) and pain intensity 3 days postoperatively. In multiple regression analyses, the cognitive-behavioral factors independently predicted different outcomes. Fear of movement/(re)injury predicted more disability and more severe pain at 6 weeks and more severe pain at 6 months; passive pain-coping strategies predicted more disability at 6 months; and negative outcome expectancies predicted more disability and more severe pain at both 6 weeks and 6 months. The findings support the potential utility of preoperative screening measures that include cognitive-behavioral factors for predicting surgical outcome, as well as studies to examine the potential benefits of cognitive-behavioral treatment to improve surgical outcome.

Keywords: Lumbar disc surgery; Chronic pain; Fear avoidance behavior; Pain coping; Outcome expectancies; Cognitive-behavioral factors

Low back pain is one of the most frequently encountered musculoskeletal disorders and is a major (and costly) problem in industrialized countries (Deyo & Phillips, 1996; Waddell, 1996). In only 5–15% of all back-related disorders there is a clear concept of pain pathogenesis, such as lumbosacral radicular syndrome (LRS) (Spitzer et al., 1987; Koes et al., 2001). The pain of LRS is caused by mechanical and chemical irritation of a lumbar nerve root by extended disc material (Nachemson, 1992). The yearly prevalence of LRS is estimated as 0.5%; complaints resolve spontaneously or with conservative treatment in 70–80% of the cases (Cherkin et al., 1994). In 20–30% of patients, surgery to remove the disc material causing the pain is recommended (Gibson et al., 1999); about 30% of such patients develop chronic disability and pain (Korres et al., 1992; den Boer et al., 2006[a]).

In the last decade, cognitive-behavioral models have provided evidence that pain-related avoidance factors, such as fear of movement/(re)injury, passive pain coping, and negative outcome expectancies, are linked to future disability and pain outcomes in patients with chronic low back pain (Vlaeyen and Linton, 2000; Pincus et al., 2002). These models are based on anxiety theories and propose that avoidance behavior occurs in anticipation of, rather than in response to, pain, which in the long term leads to decreased physical activity and deterioration of musculoskeletal and cardiovascular condition (Fordyce et al., 1982; Philips, 1987; Kori et al., 1990). A central concept is fear of movement/(re)injury, i.e., the belief that physical activity will cause renewed injury and exacerbate the pain (Vlaeyen et al., 1995[a,b]). As a consequence, passive pain-coping strategies, such as avoidance behavior and worrying about pain together with negative outcome expectancies, are assumed to support and strengthen these pain avoidance patterns and negatively affect future disability and pain (Crombez et al., 1999; Lutz et al., 1999; Evers et al., 2003; Schultz et al., 2004; Peters et al., 2005).

Studies of LRS and other types of chronic pain suggest that these cognitive-behavioral factors are important in the development of chronic disability and pain (Klenerman et al., 1995; Linton et al., 2000; Fritz et al., 2001). However, the relative contribution of fear of movement/(re)injury, passive pain-coping, and negative outcome expectancies has not yet been studied in patients with a clear pain pathogenesis, such as LRS, where clinical factors may well be significant confounding variables.

The aim of the present study was to clarify the role of preoperatively assessed cognitive-behavioral factors in postoperative disability and pain-intensity in patients who underwent surgery for LRS. We expected that patients with more fear of movement/(re)injury, patients who use more passive pain-coping strategies, or patients who have more negative outcome expectancies would show less improvement in disability and pain-intensity 6 weeks and 6 months after surgery, controlling for a number of potential confounding variables identified from the literature (i.e., preoperative pain and disability, demographic variables, clinical variables, and pain 3 days postoperatively) (den Boer et al., 2006[a]).

Methods

Participants and procedure

The sample consisted of 336 patients with LRS caused by a prolapsed or sequestered disc that compromised the L4, L5 or S1 lumbar nerve root, as confirmed by operative findings. All patients undergoing surgery for LRS at one of the four participating Dutch hospitals (UMC

St Radboud Nijmegen, Canisius Wilhelmina Ziekenhuis Nijmegen, Rijnstate Arnhem, and Viecurie Venlo) in a 2-year period were asked to participate in the study. Inclusion criteria were age older than 16 years, failure of conservative treatment, and an ability to understand and read Dutch. Exclusion criteria were previous back surgery and physical comorbidity that might interfere with postoperative rehabilitation. The decision for surgery was based on the neurosurgeons' assessments according to national guidelines (Stam, 1996). Patients were informed about the study by their clinical physiotherapist one day before surgery and, if they signed a written informed consent form, this was also the starting point of the study. Of all the patients, 11 (3%) refused to participate and 15 (4%) were not included for logistic reasons, resulting in inclusion of 310 patients at the first assessment point. There were no significant differences in mean age, gender, and educational level between the 26 nonparticipating patients and the 310 patients included in the study. Patients completed clinical tests and self-reported measures one day preoperatively, 3 days postoperatively and outcome questionnaires 6 weeks and 6 months postoperatively. The latter were sent and returned by mail.

Complete data were available for 277 (90%) patients. Reasons for dropping out were repeated surgery for the same diagnoses within the follow-up period (n = 7), physical comorbidity developed in the period following surgery that interfered with postoperative rehabilitation (n = 6), moving home (n = 4), incomplete data sets (n = 4), and refusal to participate further (n = 12). When comparing the baseline variables (demographic characteristics and preoperatively measured clinical variables and cognitive-behavioral factors) between dropouts and completers, results showed that there were no significant differences in dropouts and patients who completed all measurements. Of the 277 patients in the follow-up, 50% were female, and 33%, 47%, and 20% had a primary, secondary, or tertiary educational level. The mean age at study entry was 43 years (range 17–77). The duration of complaints was less than 3 months in 16% of the patients, longer than 3 but less than 6 months in 26% of the patients, more than 6 months but less than 1 year in 38% of the patients, and more than 1 year in 20% of the patients.

Measurement

The scales used in the study were selected on the basis of proven reliability, validity, and wide use in studies on back pain and LRS populations.

Disability was assessed one day preoperatively and 6 weeks and 6 months postoperatively, using the validated Dutch version of the Roland Disability Questionnaire (RDQ) (Beurskens et al., 1996; Gommermans et al., 1997), a 24-item questionnaire with a yes/no response format ranging from 0 to 24 (24 indicates very severe disability) that questions patients on limitations resulting from their back and/or leg pain during the past week. The questionnaire consists of items such as, "I walk more slowly than usual because of my pain" and "I dress more slowly than usual because of my pain".

Pain intensity was measured one day preoperatively, 3 days postoperatively, 6 weeks postoperatively, and 6 months postoperatively with a 10-cm Visual Analogue Scale (Price et al., 1983). The scale ranges from "no pain" to "worst conceivable pain" with a possible range of 0–100. Patients were asked to rate the average intensity of back pain and leg pain experienced over the previous week, to determine pain intensity one day preoperatively, and 6 weeks and 6

months postoperatively. At the end of the third day, patients were asked to rate the intensity of leg pain and back pain experienced on that day.

Pain-related fear of movement/(re)injury was measured one day preoperatively with the recently adjusted version of the Tampa Scale of Kinesiophobia (TKS-AV) (Goubert et al., 2004; Roelofs et al., 2004), which measures fear of increasing pain and physical injury during physical activity. The scale consists of 13 items, which are scored on a 4-point Likert scale, ranging from "totally disagree" (1) to "totally agree" (4). Representative items are, "For someone in my condition, it is inadvisable to be physically active", "My pain means that there is physical damage". The level of pain-related fear is calculated on the basis of a sum score of all 13 items (range 13–52).

Passive pain coping was measured one day preoperatively with the Pain-Coping Inventory (Kraaimaat and Evers, 2003), a pain-coping instrument that measures different cognitive and behavioral methods of dealing with pain on a 4-point Likert scale, ranging from "rarely or never" (1) to "very frequently" (4). The passive pain-coping scale consists of the scale of "Worrying" (nine items), which measures negative pain cognitions, "Resting" (five items), which measures behavioral tendencies to restrict functioning, and "Retreating" (seven items), which measures avoidance of environmental stimuli. Representative items of these scales were, "I think that the pain will worsen", "I quit my activities", and "I rest by sitting or lying down". A standardized sum score of the three separate scales was used in the analyses.

Negative outcome expectancies were measured one day preoperatively with a 4-item scale adapted from Cole et al. (2002). This scale assesses the extent to which patients expect disability, leg pain, and back pain to disappear and medical help to become unnecessary in the next 6 months. The scale is scored on a 4-point Likert scale, ranging from "totally disagree" (1) to "totally agree" (4). The level of negative outcome expectancies is calculated on the basis of a sum score of all 4 items (range 4–16).

Demographic variables were registered with a general checklist, assessing patients' gender, age, and educational level. Educational level was measured with three categories classified as primary, secondary, and tertiary educational levels, representing < 8 years, 8–14 years and >14 years of education, respectively.

Intake of analgesics was assessed preoperatively with an open-ended medication scale. Answers were subsequently categorized into six subscales, based upon the stepwise analgesic ladder. The stepwise analgesic ladder was approved by the World Health Organization (WHO) in 1990 and recommends the stepwise introduction of stronger painkillers if the more basic ones are ineffective. The scale ranges from: 1, no medication intake; 2, acetaminophen; 3, non-steroid anti-inflammatory drugs (NSAID); 4, a combination of NSAID and acetaminophen; 5, opioid; 6, a combination of opioid and acetaminophen or NSAID. Patients were asked to list the medication they had used regularly in the past week.

Neurological deficits were assessed preoperatively by the clinical physical therapist, who assessed segmental motor and sensory function of the myotomes and dermatomes of the L4, L5, and S1 nerve root on a 3-point scale: 1, no neurological deficits; 2, either sensory or motor deficits; and 3, both sensory and motor deficits.

Duration of complaints was the number of weeks the current episode of leg and/or back pain had lasted.

Statistical analyses

Mean linear changes in disability and pain intensity were studied with analyses of variance with repeated measurements, using the variables at the different assessment points as dependent variables. Paired t-tests were performed to analyze change in disability and pain intensity between baseline and 6 weeks postoperatively, and between baseline and 6 months postoperatively. To explore the relationship between preoperative predictors and changes in disability and pain intensity at 6 weeks and 6 months postoperatively, correlation coefficients were calculated between the cognitive-behavioral predictors (i.e., pain related fear of movement/(re)injury, passive pain coping, and negative outcome expectancies) at baseline as well as the possible confounding variables (i.e., preoperative status, demographic variables, clinical variables, and pain intensity 3 days after surgery) and change scores for disability and pain intensity at 6 weeks and 6 months postoperatively. Pearson correlation coefficients were used for the variables preoperative pain and disability, pain 3 days postoperatively, age, negative outcome expectancies, fear of movement/(re)injury, and passive pain coping, Spearman correlation coefficients for educational level, neurological deficits, intake of analgesics, and duration of complaints, and Point-Biserial correlation coefficient for gender. Residual gain scores (Kerlinger, 1975) were used as a change score since they take into account individual baseline values and control for regression to the mean effects. Residual gain scores were calculated by regressing the outcome variable at 6 weeks or 6 months postoperatively (e.g., disability and pain intensity at 6 weeks and at 6 months follow-up) on the baseline score of the outcome measure (e.g., disability and pain intensity one day preoperatively).

Subsequently, multiple regression analyses were performed to study the contribution of the cognitive-behavioral factors, after controlling for confounding variables that significantly correlated with change in disability and pain-intensity at follow-up assessment. The preoperative control variables and pain 3 days postoperatively were entered in, respectively, steps 1 and 2. In step 3, one of the following cognitive-behavioral factors (i.e., pain related fear of movement/(re)injury, passive pain coping, and negative outcome expectancies) was entered. To study the relative contribution of the different cognitive-behavioral factors, all cognitive-behavioral factors were entered together in step 3 in the final regression analyses. To check the possible multicollinearity of predictor variables (i.e., insufficient unique variance of different predictors due to high intercorrelations), we calculated correlation coefficients for all studied variables with each other. Results indicated that the correlation coefficients between all studied variables never exceeded $r = .40$, showing that there was sufficient unique variance of the separate predictors.

Results

Changes in disability and pain intensity during the study period

Levels of disability and pain intensity at baseline and at 6 weeks and 6 months postoperatively are presented in Table 1. During the 6-month study, there was a significant mean decrease in disability ($t = 24.81$, $p < .001$) and pain intensity ($t = 21.02$, $p = < .001$). Post hoc paired t-tests indicated that these improvements were most obvious in the first 6 weeks after surgery: disability and pain intensity markedly decreased ($t = 23.72$ $p < .001$ and $t = 20.13$, $p < .001$, respectively). After this period, disability still decreased significantly ($t = 5.01$ $p < .05$),

Table 1. Disability and pain intensity 1 day before surgery and at 6 weeks and 6 months postoperatively (N = 277)

	Preoperative		6 weeks		6 months	
	M	SD	M	SD	M	SD
Disability (0–24)[a]	15.3	4.1	7.8	5.5	6.4	6.2
Pain (0–100)[b]	47.3	21.6	17.5	18.7	18.8	22.3

[a] Disability rated on the Roland Disability Questionnaire (RDQ); scores possibly range from 0 to 24. Higher scores indicate more disability in daily activities.

[b] Pain rated on a Visual Analogue Scale (VAS); scores possibly range from 0 to 100. Higher scores indicate more pain.

whereas pain intensity remained relatively stable (t = 1.21, not sign.). Six months postoperatively, 31% and 25% of the patients still experienced relatively high levels of disability (RDQ ≥ 8, possible range 0–24) and intense pain (VAS ≥ 30, possible range 0–100) respectively, and only 34% and 49% of the patients were almost free of disability and pain, when using a cut-off point for freedom from disability or pain intensity of ≤ 1 on the RDQ and ≤ 10 on the VAS.

Predictors of disability and pain intensity 6 weeks and 6 months after surgery

The correlations between predictor variables and change in disability and pain intensity at 6 weeks and 6 months are shown in Table 2. Several baseline variables were significantly correlated with the outcome variables at 6 weeks and 6 months postoperatively: more disability preoperatively, more intense pain preoperatively, older age, female gender, lower level of education, more neurological deficits preoperatively, and more intense pain 3 days postoperatively were all correlated with less decrease in disability or pain intensity at 6 weeks and/ or 6 months postoperatively. In contrast, intake of analgesics preoperatively and duration of complaints were not associated with disability and pain intensity at 6 weeks and 6 months follow-up. Of the cognitive-behavioral factors, more pain-related fear of movement/(re)injury, more use of passive pain-coping strategies, and more negative outcome expectancies were all significantly correlated with less decrease in disability and pain intensity at 6 weeks and 6 months postoperatively.

Multiple regression analyses were performed to study the contribution of cognitive-behavioral factors, after controlling for preoperative levels of disability and pain, age, gender and educational level at step 1 and pain 3 days postoperatively at step 2. Independent predictors of more disability at both 6 weeks and 6 months postoperatively were negative outcome expectancies ($t = 2.62$, $p < .01$; $t = 3.25$, $p < .01$), more pain-related fear of movement/(re)injury ($t = 3.15$, $p < .01$; $t = 3.14$, $p < .01$), and more use of passive pain-coping strategies ($t = 2.40$, $p < .05$; $t = 3.49$, $p < .01$) (data not presented in table). Independent predictors of greater pain intensity at both 6 weeks and 6 months postoperatively were more negative outcome

Table 2

Correlations between predictors at time of surgery and change in disability and pain intensity at 6 weeks and 6 months after surgery (N = 277)

	Change in disability		Change in pain intensity	
	6 weeks	6 months	6 weeks	6 months
Preoperative control variables				
Preoperative status				
Preoperative disability			.02	.05
Preoperative pain	.04	.14*		
Demographic variables				
Age	.19**	.32**	.19**	.27**
Gender	.14*	.08	.07	.10*
Educational level	.03	.23**	.13*	.14*
Clinical variables				
Intake of analgesics	.10	.04	.07	.04
Neurological deficits	.11*	.12*	.14*	.14*
Duration of complaints	.13	.01	.08	.02
Pain 3 days postoperatively	.37**	.33**	.45**	.38**
Cognitive-behavioral variables				
Negative outcome expectancies	.21**	.26**	.25**	.30**
Fear of movement/(re)injury	.17**	.16**	.15*	.10*
Passive pain coping	.19**	.15**	.15*	.18**

Pearson correlation coefficients were used for preoperative pain and disability, pain 3 days postoperatively, age, negative outcome expectancies, fear of movement/(re)injury, and passive pain coping; Spearman correlation coefficients for educational level (1, primary; 2, secondary; 3, tertiary), neurological deficits (1, no dysfunction; 2, sensory or motor dysfunction; 3, sensory and motor dysfunction), intake of analgesics (1, no medication intake; 2, acetaminophen; 3, nonsteroid anti-inflammatory drugs (NSAID); 4, opioid; 5, a combination of NSAID and acetaminophen; 6, a combination of opioid and acetaminophen or morphine and NSAID), and duration of complaints (number of weeks since actual episode of complaints started); Point-Biserial correlation coefficient for gender (0, male; 1, female). Changes in disability and pain intensity were calculated by residual gain scores (Kerlinger, 1975). Higher levels of preoperative pain, pain 3 days postoperatively, more preoperative neurological deficits, negative outcome expectancies, fear of movement/(re)injury, passive pain-coping strategies, older age, and lower levels of education were related to less decrease in disability and pain intensity.

* $p < .05$. ** $p < .01$

expectancies (t = 3.16, p < .01, t = 4.05, p < .001),more pain-related fear of movement/(re)injury (t = 2.92, p< .01; t = 2.07, p < .05), and more passive pain coping (t = 2.19, p < .05; t = 2.62, p < .01) (data not presented in table).

In the final multiple regression analyses, the relative contribution of all cognitive-behavioral factors was tested together in one regression model. For the outcome of disability at follow-up assessment (see Table 3), preoperative control variables, pain intensity 3 days after surgery, and cognitive-behavioral factors significantly contributed 15%, 13% and 4%, respectively, to disability at 6 weeks postoperatively and 21%, 7%, and 7%, respectively, to disability at 6 months after surgery. Unstandardized ß coefficients for the full regression equation for the different cognitive-behavioral factors showed that more negative outcome expectancies (t = 2.12, p < .05) and more pain-related fear of movement/(re)injury (t = 2.39, p < .05) significantly predicted more disability 6 weeks postoperatively, and more negative outcome

Table 3
Multivariate regression analyses of disability at 6 weeks and at 6 months after surgery

	Disability 6 weeks			**Disability 6 months**		
	ß	SE	Change in R^2	ß	SE	Change in R^2
Step 1: preoperative control variables			.15			.21
Preoperative disability	0.34***	.08		0.01	.09	
Preoperative pain	0.32*	.14		0.18	.15	
Age	0.05	.02		0.12***	.03	
Gender	1.10*	.55		1.47*	.60	
Educational level	0.05	.39		1.33**	.21	
Neurological deficits	0.68	.38		0.64	.20	
Step 2: pain 3 days postoperatively	0.64***	.10	.13	0.48***	.05	.07
Step 3: cognitive-behavioral factors			.04			.07
Negative outcome expectancies	0.35*	.16		0.47**	.08	
Fear of movement/(re)injury	0.12*	.05		0.13*	.02	
Passive pain coping	0.04	.09		0.09*	.04	
Total adj. R^2			.32			.35

ß, unstandardized ß; SE, standardized error; R2, explained variance.

Higher levels of preoperative disability, preoperative pain, pain 3 days postoperatively, negative outcome expectancies, fear of movement/(re)injury, passive pain coping, older age, female gender (0, male; 1, female), and lower level of education (1, primary; 2, secondary; 3, tertiary) significantly predicted more disability at follow-up assessment.

* p < .05. ** p < .01. *** p < .001.

expectancies (t = 2.52, p < .01), more pain-related fear of movement/(re)injury (t = 2.70, p < .01), and more passive pain coping (t = 2.16, p < .01) significantly predicted more disability 6 months postoperatively. Analysis of the contribution of the different passive pain-coping scales to disability at 6 months follow-up in post hoc analyses showed that only the behavioral component of retreating significantly predicted disability at 6 months postoperatively (p < .001). For the outcome pain intensity at follow-up assessment (see Table 4), preoperative control variables, pain intensity 3 days postoperatively, and cognitive-behavioral factors significantly contributed 12%, 23%, and 4%, respectively, to pain intensity at 6 weeks and 21%, 11%, and 5%, respectively, to pain intensity at 6 months postoperatively (Table 4). Unstandardized ß coefficients showed that more negative outcome expectancies (t = 2.71, p < .01) and more pain-related fear of movement/(re)injury (t = 2.37, p < .05) significantly predicted more intense pain at 6 weeks after surgery, and more negative outcome expectancies (t = 3.62, p < .001) predicted more intense pain at 6 months after surgery.

Table 4

Multivariate regression analyses of pain intensity at 6 weeks and at 6 months after surgery

	Pain intensity 6 weeks			Pain intensity 6 months		
	ß	SE	Change in R^2	ß	SE	Change in R^2
Step 1: preoperative control variables			.12			.21
Preoperative disability	0.04	.04		0.03	.05	
Preoperative pain	0.08	.08		0.24**	.09	
Age	0.02*	.01		0.07***	.02	
Gender	0.44	.30		1.00*	.36	
Educational level	0.26	.22		0.41	.26	
Neurological deficits	0.44*	.20		0.60*	.25	
Step 2: pain 3 days postoperatively	0.51***	.05	.13	0.41***	.07	.12
Step 3: cognitive-behavioral factors			.04			.05
Negative outcome expectancies	0.25**	.03		0.13***	.03	
Fear of movement/(re)injury	0.07*	.05		0.04	.02	
Passive pain coping	0.01	.05		0.04	.06	
Total adj. R^2			.39			.38

ß unstandardized beta; SE, standardized error; R^2, explained variance.

Higher levels of preoperative pain, pain 3 days postoperatively, more preoperative neurological deficits (1, no dysfunction; 2, sensory or motor dysfunction; 3, sensory and motor dysfunction), negative outcome expectancies, fear of movement/(re)injury, older age, and female gender (1, male; 2, female) significantly predicted more pain intensity at follow-up assessment. p < .05. ** p < .01 .*** p < .001.

Discussion

The present study provides evidence about the importance of cognitive-behavioral factors in identifying patients at risk for an unfavorable outcome after lumbar disc surgery. Higher levels of pain-related fear of movement/(re)injury, use of more passive pain coping strategies, and more negative outcome expectancies were predictive for more disability and more severe pain at both 6 weeks and 6 months after lumbar disc surgery. In addition to findings on nonspecific low back pain, the results support the predictive value of a comprehensive set of cognitive-behavioral factors in back-related disorders with a relatively clear pain-pathogenesis at a relatively early preoperative stage, after controlling for a wide range of possible confounding variables. The findings support the potential of prediction of continuing disability and pain intensity for individual patients, based upon preoperative risk screenings measures that include cognitive-behavioral factors.

To our knowledge, this is the first prospective study to investigate the predictive value of preoperative pain related fear of movement/(re)injury on disability and pain intensity after lumbar disc surgery. Results indicate that patients more fearful that increasing physical activity could lead to more severe pain or re-injury reported more disability and more severe pain after lumbar disc surgery, even after controlling for levels of pain and disability prior to surgery. The findings extend previous results of several cross-sectional and prospective studies of nonspecific low back pain (Crombez et al., 1999; Swinkels-Meewisse et al., 2003; Peters et al., 2005) by showing that, even when there are relatively clear pain mechanisms, the cognitive component of pain-related fear of movement/(re)injury affects future disability and pain intensity at a relatively early preoperative stage, supporting its relevance in continuing disability and pain after surgery for LRS. In addition to fear of movement/(re)injury, use of more passive pain-coping strategies independently was associated with more disability at 6 months. The results are in line with recent findings identifying passive pain coping as a risk factor for the development of disabling neck and/or low back pain (Mercado et al., 2005) and further confirm the maladaptive nature of passive pain coping. However, we found that the passive pain-coping strategy of retreating most consistently predicted disability at 6 months, suggesting that a tendency to avoid environmental stimuli when suffering from pain seems to be most decisive in continuing disability after surgery for LRS.

Negative outcome expectancies most consistently predicted both disability and pain intensity at 6 weeks and 6 months after surgery. In addition to pain-related cognitive-behavioral factors, thoughts that surgery might not resolve the pain problem independently predicted future disability and pain intensity. The results are in accordance with research findings on general outcome expectancies, showing that pessimism (i.e., the expectation that bad outcomes generally occur when confronted with problems across major life domains) predicts worse health outcomes (see review Mondloch et al., 2001).

Pain experienced 3 days after surgery for LRS was consistently associated with more disability and more severe pain at both 6 weeks and 6 months. There is preliminary evidence that continuing nociception is associated with alterations in the peripheral and central processing of pain (Coderre et al., 1993; Woolf & Chong, 1993; Wilder-Smith et al., 2002). These alterations, which are termed neuroplasticity, are considered to play a role in postoperative

pain and the development of chronic pain, and hence are relevant to long-term pain outcomes after acute pain. However, at this time it is not more than speculative that neuroplasticity plays a role in the development of chronic pain after surgery for LRS and is responsible for the predictive contribution of pain 3 days after surgery to follow-up outcomes.

What are the implications of our results to cognitive-behavioral models for the development of chronic disability and pain in patients with LRS? In line with assumptions of cognitive-behavioral models, we found that, after controlling for other relevant preoperative variables and pain intensity 3 days after surgery, cognitive-behavioral factors independently contributed to disability and pain intensity. This association emerged using measures that were assessed prior to surgery, supporting a conclusion that the relationships exist regardless of biomedical factors, such as disc degeneration, scar tissue, and muscular instability, which could also contribute to disability and pain intensity after surgery. The fact that patient's preoperative pain coping styles, fear of movement/(re)injury, and expectancies predict postoperative disability and pain intensity, at a time point before the actual source of complaints is removed by medical intervention, suggests that the postoperative complaints are not merely a consequence of surgery, but may be influenced by cognitive-behavioral factors arising from prior learning history, predispositional factors, social factors, information from health care providers, and/or cultural background (see, e.g., Philips, 1987; Turk & Okifuji, 2002). Because our results were similar to those reported for chronic musculoskeletal pain (e.g., low back pain, rheumatic disease), they provide also further support for the role of cognitive- behavioral factors in the development of chronic pain in other populations.

Although our study included a substantial number of participants with pain of similar origin, had a relatively low percentage of dropouts, and a longitudinal design and controlled for potential confounding variables, it did have some limitations. First, although the follow-up time of 6 months may be considered relatively short, we chose it on the basis of previous studies that reported no significant decrease in pain between 6 months and longer follow-ups (Junge et al., 1995). However, it would be advisable to use longer follow-up periods in future studies. Evers et al. (2003) have previously shown that cognitive-behavioral factors predict disability for several years after diagnosis in chronic pain patients. Second, although relatively few patients did not complete the 6-month assessment, this may have influenced the results; however, the demographic characteristics, preoperatively measured clinical variables, and cognitive-behavioral factors of the dropouts were not different from those of the people who completed all assessments. Third, outcome measures were measured by self-report and so the results could reflect some shared method variance. To gain insight into the process by which disability and pain caused by pathology with a relatively clear pain-pathogenesis mechanism lead to continued disability and pain after the actual source of complaints is removed by medical intervention, it would be necessary to carry out multiple repeated measurements of cognitive-behavioral factors. Because we were interested in whether cognitive-behavioral factors predict disability and pain, we focused on group level associations. Future studies should focus on the validation of a cognitive-behavioral screening instrument to identify individual patients at risk of pain and disability after surgery for LRS.

Our results clearly show that relatively many patients still experience disability and pain at 6 months after surgery. The findings support the development and evaluation of preoperative

risk screenings measures that include cognitive-behavioral factors, as well as future research to evaluate the effectiveness of cognitive-behavioral interventions in conjunction with surgery. The finding that cognitive-behavioral factors similarly affect short-term and long-term follow-up suggests that it is preferable to start interventions to prevent patients from continued disability and pain intensity at an early postoperative stage and evaluate the effect at the short-term and longer-term follow-up after surgery.

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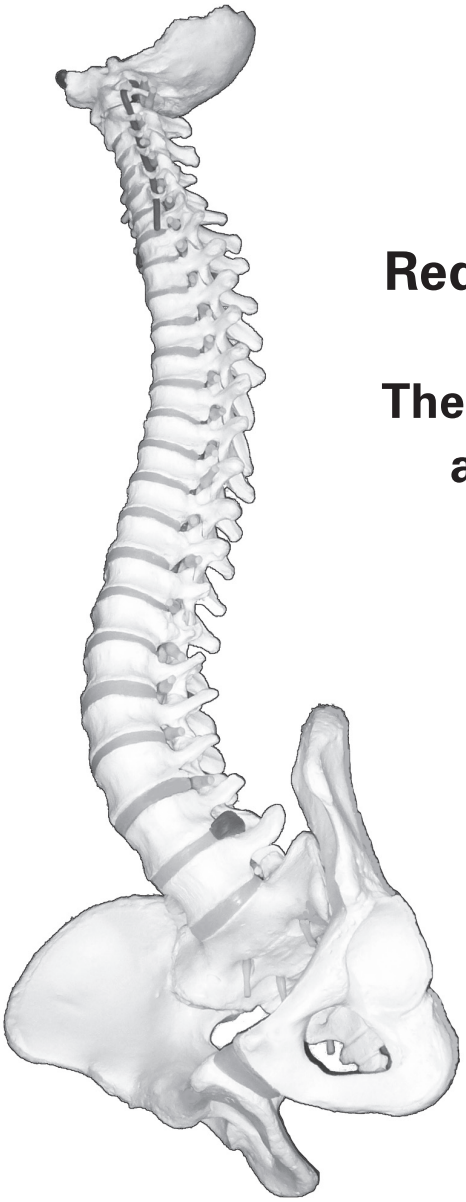

CHAPTER 4

Reduced work capacity after lumbar disc surgery: The role of cognitive-behavioral and work-related risk factors

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Abstract

A significant number of patients who have had surgery for lumbosacral radicular syndrome still have reduced work capacity several months later. In a prospective cohort study of 182 patients who underwent lumbar disc surgery, we determined the predictive value of preoperatively measured cognitive-behavioral and work-related factors on work capacity 6 months after surgery. Logistic regression analyses indicated that these factors independently predicted work capacity 6 months after surgery. Specifically, fear of movement/(re)injury, more passive pain coping, and higher physical work load predicted reduced work capacity in multiple logistic regression analyses, taking into account the role of a wide range of control variables including demographic variables, preoperative disability and pain intensity, neurological deficits, intake of analgesics, duration of complaints, and pain intensity 3 days postoperatively. The study supports the need to develop and evaluate preoperative risk screening measures that include both cognitive behavioral and work-related factors and to evaluate the effectiveness of cognitive-behavioral and work-related interventions in patients at risk of reduced work capacity after surgery for LRS.

Keywords: Lumbar disc surgery; Fear avoidance behaviour; Pain coping; Physical work load; Cognitive-behavioral risk factor; Work-related risk factor

Low back pain is a major problem in industrialized countries (Deyo & Phillips, 1996; Waddell, 1996); however, in only 3-5% of all back-related disorders there is a relatively clear pathogenic explanation for the pain, such as a lumbosacral radicular syndrome (LRS) caused by a herniated lumbar disc (Spitzer et al., 1987; Koes et al., 2001), with a clear recommendation for surgery to remove the disc material (Gibson et al., 1999). Of these patients, about 25% have a reduced work capacity in the long term (den Boer et al., 2006[a]), and it is these patients that contribute the most to the economic and social burden of low back pain (Hashemi et al., 1997; Williams et al., 1998).

There is growing interest in the timely prediction of future loss of work capacity after low-back injury (see review, Crook et al., 2002), given that early preventive interventions decrease the cost and burden to society and increase the effectiveness of treatment. Cognitive-behavioral models provided supportive evidence that pain-related avoidance factors, such as fear of movement/(re)injury, passive pain coping, and negative outcome expectancies, are associated with future outcomes including pain, disability, and work capacity in patients with back-related disorders (Fritz et al., 2001; Schultz et al., 2004; Gehldof et al., 2005; den Boer et al., 2006[b]). These models are based on anxiety theories and propose that avoidance behavior occurs in anticipation of, rather than in response to, pain (Fordyce et al., 1982; Lethem et al., 1983), which in the long-term leads to reduced work capacity. Additionally, several aspects of work predict future work capacity. Specifically, a higher physical work load, which directly affects the biomechanical load through posture, movement, and exerted forces, has been shown to predict future loss of work capacity (Wickström and Pentti, 1998; Elders et al., 2003). Moreover, psychosocial work-related factors affect return to work. Specifically a lack of job satisfaction may be an additional barrier against the resumption of professional activities (Tubach et al., 2002).

To date, only one cross-sectional study has incorporated both cognitive-behavioral and work-related factors (Gehldof et al., 2005). This study showed that fear of movement/(re)injury and physical work load were related to sick leave in patients with low-back pain. Consequently, there is a need for prospective research examining the relative contribution of different cognitive-behavioral and work-related factors. To this end, we recruited patients with back pain due to a relatively clear pathology (LRS) that had been operated on and monitored them for 6 months. Our aim was to clarify the role of cognitive-behavioral factors (fear of movement/(re)injury, passive pain coping, negative outcome expectancies) and work-related factors (physical work load, job satisfaction, duration of sick leave) on work capacity 6 months after surgery, controlling for variables previously shown to predict the outcome of lumbar disc surgery (i.e., demographic characteristics, preoperative level of disability, pain intensity, neurological deficits, intake of analgesics, duration of complaints, pain intensity three days postoperatively) (see den Boer et al., 2006[b]).

Methods

Participants and procedure

The study population consisted of the working population of the previous published study on the role of cognitive behavioral factors for continued disability and pain in LRS (den Boer et al., 2006[b]). All patients undergoing surgery for LRS at one of the four participating Dutch

hospitals (University Medical Centre St Radboud Nijmegen, Canisius Wilhelmina Ziekenhuis Nijmegen, Rijnstate Arnhem, Viecurie Venlo) over a 2-year period were asked to participate in the study. Inclusion criteria were age older than 18 years, failure of conservative treatment, an ability to understand and read Dutch, and having a paid job before the actual episode of complaints started. Exclusion criteria were previous back surgery and physical comorbidity that might interfere with postoperative rehabilitation. According to Dutch national guidelines (Stam, 1996), LRS has to be diagnosed by at least three medical specialists (i.e., general practitioner, neurologist, neurosurgeon) before surgery can be considered. The final decision to operate is based on imaging (MRI, CT) findings, which should clearly show a prolapsed or sequestered disc that compromises a lumbar nerve root. Patients were informed about the study by their clinical physiotherapist one day before surgery, and if they signed a written informed consent form, this was also the starting point of the study. Of 218 eligible patients with LRS caused by a prolapsed or sequestered disc that compromised the L4, L5, or S1 lumbar nerve root (as confirmed by operative findings), 10 (5%) refused to participate and 8 (4%) were not involved because of logistic problems, resulting in the inclusion of 200 patients at the first assessment point. Patients completed clinical tests and self-reported measures one day preoperatively and 3 days postoperatively, and a questionnaire on work capacity 6 months postoperatively (returned by mail). There were no significant differences in mean age and gender between the 18 non-participating patients and the 200 patients included in the study. Complete data were collected for 182 patients (90%). Reasons for dropping out were repeated surgery for the same diagnosis within the follow-up period (n = 4), physical comorbidity developing in the period following surgery that interfered with postoperative rehabilitation (n = 5), lost to contact (change of address) (n = 5), and refusal to participate further (n = 4). There were no significant differences in demographic characteristics or preoperatively measured clinical variables, cognitive-behavioral factors, and work-related factors between the dropouts and the patients who completed all assessments. Of the 182 patients, 41% were female, and 28%, 47%, 25% had a primary, secondary, or tertiary educational level, respectively. The mean age at the time of study entry was 41 years (range 19–61).

Measurement

The scales used in the prospective study were selected on the basis of proven reliability, validity, and wide use in studies of low back pain and LRS.

Work capacity

Work capacity at the 6-month follow-up was assessed with a self-report measure of perceived work capacity. The work capacity was rated as a percentage of the work capacity in comparison with the work capacity before the pain episode started. For example, if patients worked 40 hours a week before the pain complaints started and worked 20 hours a week at the 6-month follow-up, the work capacity was defined as 50%. Patients who worked less than 100% at the 6-month follow-up were considered to have a reduced work capacity. The self-report measurement of work capacity is widely used and has been validated in numerous studies of the prediction of future work capacity (see e.g., Schade et al., 1999; van der Giezen et al., 2000; Fritz et al., 2001; Schultz et al., 2004; Gehldof et al., 2005).

Cognitive-behavioral factors

Pain-related fear of movement/(re)injury was measured one day preoperatively with the recently adjusted version of the Tampa Scale of Kinesiophobia (TKS-AV) (Goubert et al., 2004), which measures fear of increasing pain and physical injury during physical activity. The scale consists of 13 items, which are scored on a 4-point Likert scale (1, totally disagree; 4, totally agree). Representative items are, "For someone in my condition, it is inadvisable to be physically active", "My pain means that there is physical damage". Pain-related fear was calculated as the sum of the scores for all 13 items (range 13–52).

Passive pain coping was measured one day preoperatively with the Pain Coping Inventory (Kraaimaat & Evers, 2003), a pain-coping instrument that measures different cognitive and behavioral methods of dealing with pain, which are scored on a 4-point Likert scale (1, rarely or never; 4, very frequently). The passive pain coping scale consists of the scale "Worrying" (9 items), which measures negative pain cognitions; "Resting" (5 items), which measures behavioral tendencies to restrict functioning; and "Retreating" (7 items), which measures avoidance of environmental stimuli. Representative items of these scales are, "I think that the pain will worsen", "I quit my activities", and "I rest by sitting or lying down". A standardized sum score for the three scales was used in the analyses (see also Evers et al., 2003).

Negative outcome expectancies were measured one day preoperatively with a 5-item scale adapted from Cole et al. (2002). This scale assesses the extent to which patients expect disability, leg pain, and back pain will disappear, medical help to become unnecessary, and a full return to their previous job at the 6-month follow-up. The scale is scored on a 4-point Likert scale (1, totally disagree; 4, totally agree). Negative outcome expectancy was calculated as the sum of the scores for all five items (range 5–20).

Work related factors

Physical work load was measured preoperatively with the short version of the Questionnaires on Musculoskeletal Load and Health Complaints (Hildebrandt & Douwes, 1991). Patients rated on a 4-point Likert scale (1, seldom or never; 4, very frequently) how frequently they usually performed different physical movements during their work (standing for a long time, bending, kneeling, carrying heavy loads, high strenuous arm load). The physical work load was calculated as the sum of the scores for all five items (range 5–20).

Job satisfaction was measured preoperatively with the job satisfaction scale (Symonds et al., 1996), a 7-item scale that measures satisfaction with work on a 5-point Likert scale (1, highly disagree; 5, totally agree). Representative items are: "I like my job", "I would recommend my job to my friends". Job satisfaction was calculated as the sum of the scores for all seven items (range 7–35).

Duration of sick leave was registered as the number of days of sick leave for the current episode of leg and back pain.

Demographic variables

Demographic characteristics were registered with a general checklist, assessing patients' gender, age, and educational level. The latter was measured with three categories classified

as primary, secondary and tertiary educational levels, representing >8 years, 8–14 years, and <14 years of education.

Clinical variables

Disability preoperatively was measured with the Dutch version of the Roland Disability Questionnaire (RDQ) (Gommermans et al., 1997), a 24-item questionnaire with a yes/no response format that asks patients about limitations due to their pain. Scores range from 0 to 24 (24, very severe disability). The questionnaire consisted of items such as: "I walk more slowly than usual because of my pain" or "I get dressed more slowly than usual because of my pain". Preoperative disability was calculated as the sum of the scores for all 24 items (range 0–24).

Pain intensity was measured one day preoperatively and 3 days postoperatively with a 10 cm visual analogue scale (Price et al., 1983). The scale ranges from "no pain" to "worst conceivable pain" with a possible range of 0–100. Patients were asked to rate the average intensity of back pain and leg pain experienced over the previous week, to determine pain intensity one day preoperatively. At the end of the third day, patients were asked to rate the intensity of leg pain and back pain experienced on that day.

Intake of analgesics was assessed preoperatively with an open-ended medication scale. Answers were subsequently categorized into six subscales, based upon the stepwise analgesic ladder. The stepwise analgesic ladder was approved by the World Health Organization (WHO) in 1990 and recommends the stepwise introduction of stronger painkillers if the more basic ones are ineffective. The scale ranges from: (1) no medication intake, (2) acetaminophen, (3) nonsteroid anti-inflammatory drugs (NSAID), (4) a combination of NSAID and acetaminophen, (5) opioid, and (6) a combination of opioid and acetaminophen or NSAID. Patients were asked to list the medication they had used regularly in the past week.

Neurological deficits were assessed preoperatively by a clinical physiotherapist who tested the motor and sensory function of the myotomes and dermatomes of the L4, L5, and S1 nerve root. Function was categorized into three subscales: (1) no neurological deficits, (2) either sensory or motor deficits, and (3) both sensory and motor deficits.

Duration of complaints was registered as the number of days the current episode of leg and back pain had lasted.

Statistical analyses

To investigate the relationship between the preoperative predictors and work capacity at the 6-month follow-up separately, we performed univariate logistic regression analyses with the cognitive-behavioral predictors (i.e., pain-related fear of movement/(re)injury, passive pain coping, negative outcome expectancies), work-related factors (physical work load, job satisfaction, duration of sick leave), and control variables (i.e., demographic variables, preoperative disability and pain intensity, medication intake, neurological deficits, duration of complaints, pain intensity 3 days postoperatively) at baseline as independent variables and work capacity at 6 months postoperatively as dependent variable. To study the relative contribution of the different cognitive-behavioral factors, work-related factors, and control variables, all variables that significantly predicted work capacity at the 6-month follow-up assessment ($p < .05$) in the univariate analyses were then entered together in multiple regression analysis.

Results

Work status at 6-month follow-up

Of the 182 patients, 141 (77.5%) made a full return to work and 41 (22.5%) did not. The latter were considered to have a reduced work capacity.

Table 1.

Mean and standard deviation of the predictors at baseline for patients who returned 100% to their previous job and who did not, and results of univariate logistic regression analyses between baseline variables and work capacity at 6 months follow-up

	Return to work (n = 141)		Not return to work (n = 41)		Univariate logistic regression
	Mean	SD	Mean	SD	ß
Control variables					
Demographic variables (score range)					
Age	40.4	9.1	43.0	9.7	.03
Gender (female = 1, male = 2)	1.4	1.5	1.4	1.5	.04
Educational level	2.0	0.7	1.7	0.7	.18
(primary = 1, secondary = 2, tertiary = 3)					
Clinical variables					
Disability preoperatively (0–24)	14.8	3.2	16.3	4.2	.10*
Pain preoperatively (0–100)	45.0	20.9	52.5	21.7	.01
Onset of complaints (acute=1, not acute = 2)	1.7	0.5	1.8	0.4	.54
Medication intake (1–6)	2.7	2.0	3.1	1.9	.10
Neurological deficits (1–3)	2.1	0.6	2.3	0.7	.51*
Duration of the current pain episode (number of weeks)	37.2	27.5	36.1	29.8	.01
Pain 3 days after surgery (0–100)	22.8	22.9	29.5	17.9	.01*
Cognitive behavioural factors					
Negative outcome expectancies (5–20)	10.2	1.7	10.7	1.5	.18
Fear of movement/(re)injury (13–52)	39.2	6.3	42.1	5.8	.11**
Passive pain coping (21–84)	39.8	7.8	44.8	7.6	.10***
Work related factors					
Physical work load (5–20)	9.0	3.8	10.9	3.7	.12**
Job satisfaction (13–65)	56.2	13.6	50.7	9.6	.49*
Duration of sick leave (number of weeks)	12.5	22.1	17.5	12.5	.46**

ß, unstandardized beta. * $p < .05$. ** $p < .01$. *** $p < .001$.

Predictors of work capacity at 6-month follow-up

Results of univariate analyses showed that of the control variables, only a lower educational level, more disability preoperatively, more neurological deficits, and greater pain intensity 3 days postoperatively significantly predicted a reduced work capacity at 6-months follow-up (see Table 1). Of the cognitive-behavioral factors, more fear of movement/(re)injury and more passive pain coping significantly predicted a reduced work capacity. Of the work-related variables, higher physical work load, lower job satisfaction, and longer duration of sick leave significantly predicted a reduced work capacity at the 6-month follow-up.

Multiple logistic regression analyses, controlled for the variables preoperative disability, educational level, neurological deficits, and pain 3 days postoperatively, showed that more fear of movement/(re)injury, more passive pain coping, and higher physical work load significantly predicted a reduced work capacity. In contrast, none of the control variables predicted work capacity at the 6-month follow-up in multiple regression analyses (see Table 2). The overall significance of the model was $p < 0.001$ and the R^2 (Nagelkerke's R^2) was 0.38. With regard to the relative magnitude of effects, an odds ratio of fear of movement/(re)injury of 1.09 means that the risk of a reduced work capacity increases by 1.09 for every point on the fear of movement/(re)injury scale (possible range 13–52). Thus a score one SD (5.5) higher on the fear of movement/(re)injury scale (score range, 13–52) increased the risk of a reduced

Table 2

Multivariate logistic regression analyses of work capacity at 6 months after surgery

	Work at 6 months after surgery				
	ß	SE	p	Odds ratio	`N` R^2
Control variables					
Educational level					
(1 = primary, 2 = secondary, 3 = tertiary)	.02	.14	.91	0.98	
Disability preoperatively (0–24)	.01	.07	.83	1.02	
Neurological deficits preoperatively (1–3)	.42.	29	.12	1.57	
Pain 3 days postoperatively (0–100)	.01	.01	.13	1.01	
Cognitive-behavioral and work related factors					
Fear of movement/(re)injury (13–52)	.09	.04	.03*	1.09	
Passive pain coping (21–84)	.08	.04	.03*	1.08	
Physical work load (5–20)	.17	.06	.00**	1.19	
Job satisfaction (13–65)	.02	.04	.64	0.98	
Duration of sick leave (number of weeks)	.23	.19	.24	1.26	
Overall significance			.00***		
Nagelkerke's R^2					.38

ß, unstandardized beta, SE, standardized error. * $p < .05$. ** $p < .01$. *** $p < .001$.

work capacity by 1.6; a score 1 SD (7.7; OR = 1.08) higher on the passive pain coping scale (range 21–84) increased the risk of a reduced work capacity by 1.9; and a score 1 SD (3.8; OR = 1.19) higher on the physical work load scale (score range, 5–20) increased the risk of a reduced work capacity by 2.0.

Discussion

The present findings support the importance of cognitive-behavioral and work-related factors in determining a person's work capacity after lumbar disc surgery. Results from multiple logistic regression analyses showed that more pain-related fear of movement/(re)injury, more use of passive pain coping strategies, and higher physical work load predicted a reduced work capacity at the 6-month follow-up. As in studies of non-specific low back pain, the results support the relevance of a comprehensive set of cognitive-behavioral and work-related factors in patients with low-back disorders with a relatively clear pain pathogenesis, after taking a wide range of control variables into account. To our knowledge, this is the first prospective study showing that both cognitive-behavioral and work-related factors independently predict future loss of work capacity.

In the present study, 77.5% of the patients made a full return to work. These results are generally in line with the results of previous studies (Donceel & Dubois, 1999; Schade et al., 1999) and indicate that most patients seem to benefit from lumbar disc surgery. However, about a quarter of the patients have a reduced work capacity 6 months after surgery for LRS and may take extended sick leave, leading to high back-related costs.

The cognitive-behavioral factors previously shown to predict other outcomes after lumbar disc surgery, such as disability and pain (see also den Boer et al., 2006[b]), also predicted work capacity. Patients who were more fearful that increasing their physical activity level might lead to more pain or re-injury or those who used more passive pain coping strategies (worry and avoiding activity) had a lower work capacity at the 6-month follow-up. In a cross-sectional study of 129 employees with low back pain, Gehldof et al. (2005) showed that fear of movement/(re)injury was a unique risk factor for both short-term and longer term sick leave, and Symonds et al. (1996) showed prospectively in a population of 156 office workers and 262 factory workers with low back pain that more fear avoidance beliefs about work predicted a longer period of absence from work.

We found that physical work load (lifting heavy objects, repeated heavy arm tasks and longstanding standing and kneeling labor) independently added variance to the prediction of reduced work capacity 6 months after surgery. These results confirm the growing evidence from cross-sectional and prospective research of patients with non-specific low back pain that a higher physical work load is a major and unique risk factor for reduced work capacity in the long term. For example, Elders et al. (2003) showed prospectively that physical work load was a risk factor for low back pain-related sickness absence among scaffolders. In a 24-month prospective study (Wickström & Pentti, 1998) among Finnish employers in heavy industry, physical work load predicted recurrent low back pain resulting in sick leave. In contrast, we found job satisfaction to be only modestly associated with reduced work capacity at 6 months (univariate logistic regression analysis). The results for job satisfaction are consistent with those of several studies of LRS and non-specific low back pain (Schade et al., 1999; Tubach et

al., 2002; Gehldof et al., 2005) and showed that job satisfaction lost its importance in multiple regression analyses, after controlling for other factors, such as preoperative levels of pain and disability and physical work load. These results suggest that of the work-related factors, physical work-related factors may be more important to work capacity than psychosocial factors such as job satisfaction.

Our finding that both higher levels of fear of movement/(re)injury and greater physical job demands predicted reduced work capacity might imply that patients should not be afraid to be physically active after surgery for LRS; however, striking the right balance is important because too much physical activity in combination with a high work load might contribute to reduced work capacity. The effects of fear of movement might depend on various factors and there may be times and situations when fear of movement is an adaptive strategy to prevent patients from future work loss, such as in patients with relatively higher work load and in an acute phase of complaints. Future studies should investigate the possible effects of fear of movement/(re)injury in patients with different work loads and in different stages of pain-related loss of work; for instance, investigate the incidence and further development of acute pain into chronic pain over a longer time in a working population with different physical work loads and levels of fear of pain.

Some limitations of the study have to be considered. First, the follow-up was relatively short and further studies are needed to replicate our findings for longer follow-up periods, to determine whether this loss of work capacity leads to chronic sick leave. Second, although relatively few patients did not complete the 6-month assessment and the demographic and baseline variables of the dropouts were not different from those of the people who completed all assessments, we cannot exclude a small selection bias. Third, although we selected the control variables on the basis of a systematic review of predictors of outcome, other variables may affect work capacity after lumbar disc surgery, such as physical strength and fitness or the level of social support (e.g., Mayer et al., 1989; Evers et al., 2003). Fourth, we cannot rule out the possibility that at the 6-month follow-up patients had medical restrictions caused by neurological deficits that contributed to their change in work capacity. And last, although this self-report measurement of work capacity has been validated in numerous studies of the prediction of future work capacity (see e.g., Schade et al., 1999; van der Giezen et al., 2000; Fritz et al., 2001; Schultz et al., 2004; Gehldof et al., 2005), it could be argued that a less stringent definition of "reduced work capacity" should be used (e.g., 70% instead of 100% of previous work capacity at 6 months after surgery), but when we used the less stringent definition of 70% we found the same variables (i.e., fear of movement/(re)injury, passive pain coping, physical work load) to still predict reduced work capacity at 6 months. Future studies should further validate this assessment method by comparing it to other measurements of work capacity, such as self-report "time to return to work" or work capacity assessed by the medical adviser.

In terms of implications for clinical practice, our results show that a substantial number of patients with LRS (22.5%) have a reduced work capacity 6 months after surgery and that it is possible to predict this work loss by using a broad set of cognitive-behavioral and work-related factors, in addition to clinical and demographic variables. The study supports the need to develop and evaluate preoperative risk screening measures that include both cognitive-

behavioral and work-related factors. To get an indication of the relative magnitude and clinical significance of these predictors, future studies should evaluate the effectiveness of cognitive-behavioral and work-related interventions in patients at risk of reduced work capacity after surgery for LRS.

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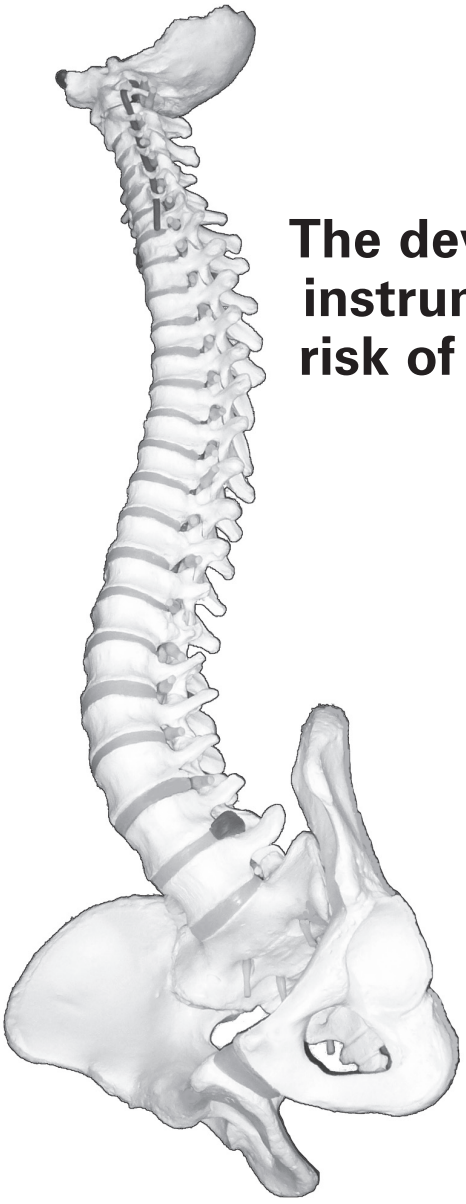

CHAPTER 5

The development of a screening instrument to select patients at risk of residual complaints after lumbar disc surgery

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Jasper J. den Boer, Rob A.B. Oostendorp, Andrea W.M. Evers, Tjemme Beems, George F. Borm, Marten Munneke. The development of a screening instrument to select patients at risk of residual complaints after lumbar disc surgery

Abstract

***Study design**: A prospective cohort study.*

***Objective:** To develop a brief screening instrument to identify patients at risk of residual complaints after surgery for a lumbosacral radicular syndrome (LRS).*

***Summary of background data:** A considerable number of patients who undergo surgery for LRS continue to experience disability, pain, and loss of work capacity. There is a need for a brief screening instrument to identify these patients at risk of residual complaints.*

***Methods:** In a prospective study of 277 patients, the predictive value of selected variables on the outcomes disability, pain, and loss of work capacity was investigated. Potential predictive variables were selected on the basis of the results of previous analyses involving the same patient population. The best predictive model was constructed using a stepwise selection procedure (forward selection), the discriminative power of the model was calculated. Based on the relationship between regression coefficients, a clinical prediction rule was derived that predicted the probability of residual complaints after surgery for LRS.*

***Results:** At 6 months follow-up 142 (51%) had residual complaints. The discriminative power of the instrument was .78 (AUC). The 'Nijmegen Outcome of Lumbar Disc surgery Screening-instrument' (NOLDS) was based on the variables 'education level', 'age', 'pain 3 days postoperatively', 'passive pain coping', and 'fear of movement/(re)injury'.*

***Conclusion:** The results of the study are promising, showing that a brief clinical screening instrument can be used to identify, 3 days after surgery, patients at risk of residual complaints at 6 months after surgery for LRS. The early identification of patients at risk having residual complaints will enable tailored treatment to be started early in the rehabilitation process.*

***Key words:** Lumbar disc surgery, Prognosis, Screening instrument.*

Lumbosacral radicular syndrome (LRS) is one of the few back-related disorders in which there is a clear concept of the pain pathogenesis (Spitzer et al., 1987; Koes et al., 2001). In 90% of the patients, LRS is caused by mechanical and chemical irritation of a lumbar or sacral nerve root by extended disc material (Mixter & Barr, 1934; Nachemson, 1992; Boos et al., 2000). In about 30% of patients LRS is accompanied by sensory loss and motor disturbances (Eysel et al., 1994). The estimated annual incidence of LRS in Western countries is 0.5% (Cherkin et al., 1994; Younes et al., 2006). While symptoms resolve spontaneously or with conservative treatment, 20-30% of patients continue to experience disability and pain for more than one year (Weber et al., 1993; Vroomen et al., 2000; Peul et al., 2007). In these patients surgery is recommended to remove the extended disc material (Gibson et al., 1999); however, about 30% of these patients continue to experience disability, pain, and loss of work capacity after surgery (Korres et al., 1992; den Boer et al., 2006[a]). Since most of the direct and indirect costs of surgery for LRS can be attributed to this relatively small proportion of patients, an important aim of postoperative treatment is to prevent the development of chronic symptoms. While a considerable amount of research effort has been invested in the identification of risk factors associated with the transition from acute to chronic symptoms in patients with non-specific low back pain, and several clinical screening instruments have been developed (Linton et al., 2003; Hilfiker et al., 2007; Jellema et al., 2007), there are no brief screening instruments for clinical use to identify patients at risk of residual complaints after surgery for LRS. The aim of this study is to develop such a screening instrument.

Methods

Participants and procedure

All patients undergoing surgery for LRS at one of the four participating Dutch hospitals (UMC St Radboud Nijmegen, Canisius Wilhelmina Ziekenhuis Nijmegen, Rijnstate Arnhem, Viecurie Venlo) in a 2-year period were asked to participate in the study. Inclusion criteria were LRS due to a prolapsed or sequestered disc that compromised the L4, L5, or S1 lumbar nerve root (as confirmed by operative findings), age older than 16 years, failure of conservative treatment, and an ability to understand and read Dutch. Exclusion criteria were previous back surgery and physical comorbidity that might interfere with postoperative rehabilitation. The decision for surgery was based on the neurosurgeons' assessments according to national guidelines (Health Council of the Netherlands, 1999). Patients were informed about the study by their clinical physical therapist one day before surgery, and if they agreed to participate and signed a written informed consent form, this was the starting point of the study. All patients received physical therapy, as recommended in the Dutch multidisciplinary guideline for LRS (Health Council of the Netherlands, 1999). Of the 336 patients who underwent surgery during the inclusion period, 11 (3%) refused to participate and 15 (4%) were not included for logistic reasons, resulting in inclusion of 310 patients at the first assessment point. There were no significant differences in mean age, gender, and educational level between the 26 nonparticipating patients and the 310 participating patients. Patients completed clinical tests and self-reported measures one day preoperatively and 3 days postoperatively, and outcome questionnaire 6 months postoperatively.

Outcome

The outcome 6 months after surgery was based on the levels of disability, pain, and work capacity. The scales used to measure these variables were selected on the basis of proven reliability, validity, and wide use in studies of back pain and LRS populations. Disability was assessed using the validated Dutch version of the Roland Disability Questionnaire (RDQ) (Gommermans et al., 1997), a 24-item questionnaire with a yes/no response format ranging from 0 to 24 (24 indicates very severe disability) that asks about the limitations patients experienced as a result of back and/or leg pain in the past week. Pain intensity was assessed using a 10-cm Visual Analog Scale (VAS) (Price et al., 1983). The scale ranges from "no pain" (0) to "worst conceivable pain" (10). Patients were asked to rate the average intensity of back pain and leg pain experienced in the previous week, to determine pain intensity 6 months postoperatively. Work capacity was measured as a percentage of the work capacity before the actual pain episode started. For example, if patients worked 40 hours on weekly basis before symptoms started, and worked 20 hours at the 6-month follow-up, the work status was defined as 50%.

In general, effectiveness of intervention is achieved when the levels of change represents a clinically important difference. The minimal clinically important improvement on the Roland disability questionnaire (RDQ) and the pain score on the visual analogue scale (VAS) was studied by Jordan et al. (2006) and Farrar et al.(2000). For both scales a reduction of at least 30% was a minimally clinical important improvement. However, regardless of a clinically important improvement, patients still can have residual complaints after surgery for LRS. When developing a screening instrument for patients at risk we were specifically interested in all patients with residual complaints, and therefore, to develop a screening tool we used a the more stringent cut-of point of redisdual complaints of disability > 4 (RDQ) or pain > 2 (VAS) or work capacity <100%. The choice of this cut-of point was based on clinical experience and on the study of Ostello et al. (2005) which examined the predictive value of a complex of predictive factors measured 6 weeks after surgery on residual disability, pain and perceived recovery at 3 months and 12 months after surgery. Only patients with a paid job before surgery could score positively on loss of work capacity. Patients were classified as having residual complaints when one of the 3 score were above the cut-off score of disability > 4 (RDQ), pain >2 (VAS) or work capacity < 100%.

Baseline predictors

The selection of potential predictive variables was based on previous analyses (den Boer et al., 2006[b]) In the present study we focussed on the development of a screening instrument for residual complaints and used one outcome measure including all 3 measures disability, pain and work capacity at 6 months follow-up. Regression analysis showed that an older age, a lower level of education, female sex, more neurological deficits, more pain preoperatively and 3 days postoperatively, more disability preoperatively, more passive pain coping, more fear of movement/(re)injury, and negative expectations of recovery were associated with more disability and/or pain at 6 months after surgery for LRS.

Age was classified in decades. Educational level was classified into three categories, namely, primary, secondary, and tertiary, representing < 8 years, 8-14 years, and > 14

years of education. Neurological deficits were assessed preoperatively by physical therapists, who tested motor and sensory function of the L4, L5, and S1 nerve roots on a 3-point scale: 1. no neurological deficits, 2. either sensory or motor deficits, and 3. both sensory and motor deficits. Disability preoperatively was measured with the RDQ. Pain one day preoperatively and 3 days postoperatively was measured wth the VAS. Pain-related fear of movement/(re)injury was measured one day preoperatively with the recently adjusted version of the Tampa Scale of Kinesiophobia (TKS-AV, Goubert et al., 2004), which measures fear of increasing pain and physical injury during physical activity. Passive pain coping was measured one day preoperatively with the Pain Coping Inventory (Kraaimaat & Evers 2003), a pain-coping instrument that measures different cognitive (worrying) and behavioral (resting, retreating) methods of dealing with pain. Negative outcome expectancies were measured one day preoperatively with a scale adapted from Cole et al. (2002). This scale assesses the extent to which patients expect disability, leg pain, and back pain to disappear and medical help to become unnecessary in the next 6 months. Pain 3 days postoperatively was assessed by asking the patients to rate the intensity of leg pain and back pain (VAS) experienced on the third day postoperatively.

Statistical analyses

The prediction rule was constructed using stepwise logistic regression (forward selection). Only variables with a significance level of $< .01$ were included in the final model. For continuous variables such as age, we investigated whether including the square of the variable improved the fit of the model. Ordinal variables such as education were analyzed twice, once as class variables and once as continuous covariates. When the results of these analyses were similar, the continuous covariate model was chosen, because this led to a prediction rule with fewer coefficients. The discriminative power of the model was assessed by calculating the area under the receiver operating characteristic curve (AUC). Based on the relationship between regression coefficients, a clinical prediction rule was derived that predicted the probability of residual complaints after surgery for LRS.

Results

Study population

Complete data were available for 277 (90%) of the 310 patients who entered the study. Reasons for dropping out were repeated surgery for the same diagnoses within the follow-up period (n = 7), physical comorbidity developed in the period following surgery that interfered with postoperative rehabilitation (n = 6), moving home (n = 4), incomplete data sets (n = 4), and refusal to participate in the study (n =12). Comparison of the baseline variables (demographic characteristics and preoperatively measured clinical variables and cognitive-behavioral factors) between dropouts and completers showed that there were no significant differences in dropouts and patients who completed all measurements. Of the 277 participants, 50% were female, and 33%, 47%, 20% had a primary, secondary, or tertiary educational level, respectively. The mean age at study entry was 43 years (range 17-77). Mean of the predictors at baseline for patients whith and without residual complaints at 6 months follow-up are presented in Table 1.

Table 1: Mean and standard deviation in case of continuous variables and percentage of frequencies in case of ordinal variables at baseline

Predictors / Outcome 6 months after surgery	No residual complaints N = 136		Residual complaints N = 141	
	Mean (SD)	Frequency	Mean (SD)	Frequency
Preoperative status				
- Disability preoperatively (0-24)	14.5 (4.6)		15.9 (3.7)	
- Pain preoperatively (0-10)	4.3 (2.1)		5.1 (2.1)	
Demographic variables				
- Age	39.8 (11.1)		45.7 (10.6)	
- Educational level				
- primary		25.8 %		42.6 %
- secondary		48.5 %		45.4 %
- tertiary		25.7 %		12.1 %
- Gender				
- female		56.6 %		44.0 %
- male		43.4 %		56.0 %
Clinical variables				
- Neurological deficits				
- no deficits		30.1 %		13.5 %
- motor or sensor deficits		39.0 %		44.0 %
- motor and sensor deficits		30.9 %		42.6 %
- Pain 3 days after surgery (0-10)	1.9 (1.6)		3.2 (2.1)	
Cognitive behavioural factors				
- Negative outcome expectancies (0-12)	8.7 (1.6)		8.3 (1.9)	
- Fear of movement/(re)injury (0-39)	16.4 (5.3)		18.8 (5.2)	
- Passive pain coping (0-21)	4.1 (3.2)		5.8 (3.6)	

* $p < .05$, **$p < .01$, ***$p < .001$

Outcome

Results of the outcome regarding the clinical important reduction of complaints (reduction of 30%) showed that 79%, 77% and 82% of the patients had a clinically important decrease of disability, pain and loss of work capacity, respectively. For the development of the screening-instrument patients were divided into patients with and without residual complaints and 51 percent of the patients (n=141) were classified as having residual complaints after surgery for LRS.

Table 2. Results of stepwise logistic regression analyses using a forward selection procedure. Only variables with a significance level of < .01 were included in the final model

	No residual complaints N = 136 Residual complaints N = 141 (disability < 4 or pain < 2 or work capacity < 100%)		
	b	Se	Ods ratio
Pain 3 days postoperatively (0-10)	.33***	.08	1.4
Passive pain coping (0-21)	.12**	.04	1.1
Age (1 = 10-20, 2 = 21- 30)	.35**	.13	1.4
Education (primary = 1, secondary = 2, tertiary = 3)	.65**	.21	1.9
Fear of movement/(re)injury (0-39)	.09**	.03	1.1

* p < .05, **p < .01, ***p < .001

Development of a screening instrument

Multiple regression analyses (Table 2) using a forward selection procedure showed that the factors 'pain 3 days postoperatively', 'passive pain coping', 'educational level', 'age' and 'fear of movement(re)injury' were significant predictors of having residual symptoms 6 months following surgery (p = <. 01). The discriminative power of the model incorporating these variables was 0.78 (AUC). We derived a prediction rule based on the regression coefficients of this model. In order to simplify the rule, we multiplied the regression coefficients by 11 and rounded them off to the nearest integer. This lead to the following prediction rule: 4 x 'pain 3 days postoperatively' + 1 x 'passive pain coping' + 7 x 'educational level' + 4 x 'age' + 1 x 'fear of movement/(re)injury' which is named the 'Nijmegen Outcome of Lumbar Disc surgery Screening-instrument' (NOLDS). The NOLDS theoretically ranges from 0 (lowest probability of having residual complaints 6 months following surgery) to 142 (highest probability of having residual complaints 6 months following surgery). In this study the actual range was 26.4 to 102.8. To find 90% of patients with residual complaints, the score on the NOLDS should be at least 47. Based on this cut-off point, 53% of patients without residual complaints were also classified having residual complaints.

Validation

The estimate of the AUC may be too optimistic, because it was calculated using the same data that were used to derive the screening instrument. We carried out a bootstrap cross validation and found and optimism of 0.04, i.e. the AUC 0.78 that we found in our data, is likely to go down to 0.74 when the method is applied to new data.

Since a cut-off score is always somewhat arbitrary, in post-hoc analyses we studied the results obtained with a more stringent cut-off point of one half the maximum score on the scales measuring disability, pain, and work capacity (i.e., a RDQ score of 12, a pain score of 5, and a work capacity score of < 50%). With this cut-off, 35 (13%) of the patients had residual complaints. Results of multiple regression analyses showed that, with the exception of age and fear of movement/(re)injury, the same combination of 'pain 3 days postoperatively', 'passive pain coping', and 'educational level' predicted residual complaints (p = < 0.01) and that the discriminative power of this model increased to 0.85 (AUC).

In addition, when excluding work capacity from the cut-off point of outcome and define residual complaints solely on the score disability > 4 (RDQ) and pain > 2 (VAS), 10 patients shift from residual complaints to no residual complaints. Results from logistic regression analyses (forward selection) showed that the same variables 'pain 3 days postoperatively', 'passive pain coping', 'educational level', and 'age' were significant predictors of a poor postoperative outcome (p = <.01). The SE of the variables slightly differed, however, rounding of the SE to the nearest integer led to the same prediction rule and the discriminative power of the model remained 0 .78 (AUC) .

When rejecting patients without a paid job (N= 95), results from logistic regression analyses (forward selection) showed that the same variables except passive pain coping were significant predictors of outcome after surgery for LRS. The discriminative power of the model decreased to 0.75 (AUC).

Finally, when including patients with repeated surgery (N = 7) to the patients with residual complaints results from logistic regression analyses(forward selection) showed that the same variables 'pain 3 days postoperatively', 'passive pain coping', 'educational level', and 'age' were still significant predictors of a poor postoperative outcome (p = <.01). The SE of the variables slightly differed, however, again rounding of the SE to the nearest integer led to the same prediction rule and the discriminative power of the model remained 0 .78 (AUC) .

Discussion

We systematically developed a brief clinical screening instrument, the NOLDS, to indentify patients at risk of residual complaints after surgery for LRS. The NOLDS is based on five factors which were found to predict the outcome at 6 months after surgery for LRS. These factors are lower level of education, older age, more pain 3 days postoperatively, use of more passive pain coping strategies, and more fear of movement/(re)injury. The results of the study extend those of previous work on non-specific low back pain (Linton et al., 1998; Reis et al., 2004; Hilfiker et al., 2007; Jellema et al., 2007) by showing that, in patients operated for LRS, it is possible to screen for the risk of symptom chronification using a short list of demographic, clinical and cognitive behavioral risk factors.

Risk factor screening is a first step to select patients at risk and prevent them from developing residual complaints at an early postoperative stage. To identify the vast majority of patients with residual complaints 6 months following surgery we took a cut-off point on the NOLDS with a sensitivity of 90%. With this cut-off value (NOLDS > 47) 126 of the 141 patients with residual complaints 6 months following surgery for LRS were correctly identified 3 days following surgery. This high sensitivity of finding patients with residual complaints

Table 3. Levels of sensitivity, specificity and the corresponding cut-off point of thr screening instrument (NOLDS)

Sensitivity	Specificity	Score NOLDS
90 %	47 %	47
80 %	59 %	50
70 %	70 %	55
60 %	80 %	58

is accompanied with a relatively low specificity of 47%. This implicates that one needs to keep in mind that not all patients with a score higher then 47 on the NOLDS will have residual complaints. Other levels of sensitivity and the corresponding specificity and cut-off point of the screening instrument (NOLDS) are presented in Table 3. Future studies in other populations of patients undergoing surgery for LRS are needed to further support the validity of the screeninginstrument.

The predictive value of the NOLDS might probably be further improved by not only screening in the early phase following surgery but also repeatedly screening at different time-points at longer term follow-up after surgery for LRS. For example, Sieben et al (2002) measured in patients with acute non-specific low back pain, pain related fear at different time points during the first two weeks after onset of complaints. Results showed that rising levels of pain related fear predicted more disability at one year follow-up.

In this study we have chosen for a distinction between residual and non-residual complaints based on pain, disability and work capacity. Although outcome domains and cut-off points are based on previous studies as well clinical experience this distinction is still arbitrary chosen. Future research should therefore focus on a clear, evidence based and clinical relevant definition of residual complaints following surgery for LRS, including for instance patients own opinion about the outcome.

Clinical implication

The early (3 days postoperative) identification of patients at risk of longer-term outcome (6 months following surgery) for residual complaints using the NOLDS can be used to develop a more individual tailored postoperative treatment, providing more intensive treatment to patients high at risk and low intensive treatment or a home exercise program to patients low at risk of residual complaints. Till now, there is a lack of evidence of the effectiveness of tailored treatment based on identified risk factors after surgery for LRS. However, a number of studies on other pain populations provided evidence that customizing treatments to patient characteristics optimized treatment effects. For example, tailored cognitive behavioral interventions have shown to be effective in patients with chronic pain conditions, focusing for example on treatment strategies for pain-related avoidance behavior (George et al., 2003; Evers et al., 2002; Shaw et al., 2006).

Referral to postoperative treatment is usually organised by the clinically involved physiotherapists, and therefore screening for patients at risk is best performed by these

therapist. Future studies should examine both the effectiveness on decrease of disability, pain and loss of work capacity at longer term outcome after surgery for LRS, as well as the cost-effectiveness of intensive postoperative physiotherapy based on the risk screening instrument. At the same time, criteria should be developed when other health care providers, such as for example a medical psychologist, an occupational therapists, the neurosurgeon, a consultant of rehabilitation medicine or an anaesthetist should be consulted to support the physiotherapy regime. This will gain more insight in when multidisciplinary treatment might be more effective after surgery and which patients benefit specifically from multidisciplinary treatment.

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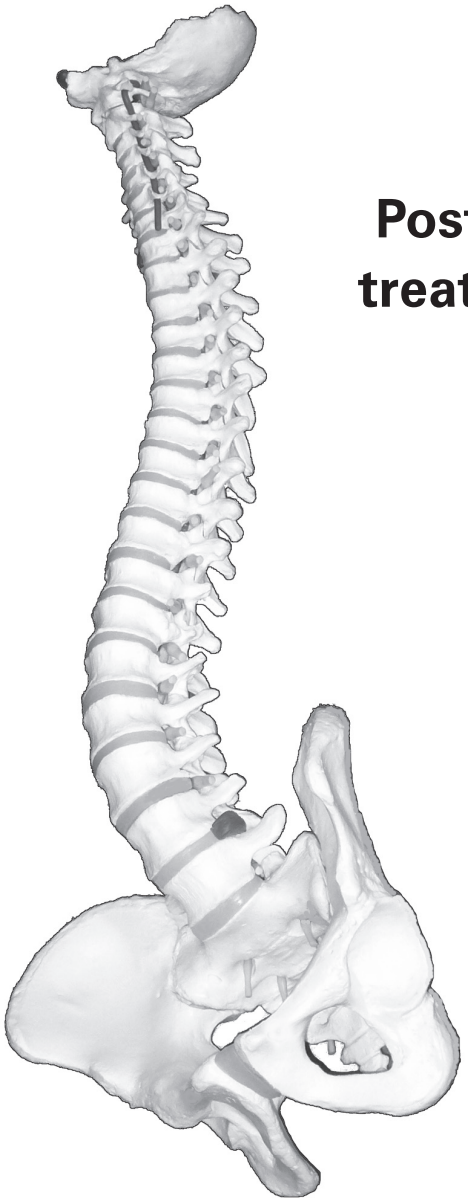

CHAPTER 6

Postoperative physiotherapy treatment characteristics and disability and pain after lumbar disc surgery

submitted for publication:
Jasper J. den Boer, Andrea W.M. Evers, Tjemme Beems, Marten Munneke, Rob A.B. Oostendorp. Postoperative physiotherapy treatment characteristics and disability and pain after lumbar disc surgery

Abstract

A relative high number of patients have residual disability and pain after surgery for a lumbosacral radicular syndrome. Dutch multidisciplinary and physiotherapy guidelines recommend that patients receive postoperative physiotherapy treatment focusing on four main treatment goals: 1. improving neuromusculoskeletal and movement-related functions; 2. improving activities and participation; 3. reduce pain; and 4. educating and advising patients about, for example, pathology or dealing with postoperative pain. In a prospective cohort study 74 physiotherapist recorded information about their postoperative treatment. Results showed that more treatment time spent on improving neuromusculoskeletal and movement related functions was associated with less disability and pain at 6 months follow-up. In addition, the frequency that physiotherapists chose the sub-goals reduce pain related fear of movement/(re)injury and passive pain coping was higher for patients who were preoperatively characterized by more pain related fear of movement/(re)injury and passive pain coping.The number of treatment sessions and the chosen sub-goals to improve the main treatment goals were not related to the outcome disability and pain 6 months after surgery. Results of the present study give some preliminary support that postoperative treatment specifically focussing on neuromusculoskeletal and movement-related functions, such as mobility, stability, muscle strength, posture, and movement pattern of the lumbar vertebral column, might lead to reduction of disability and pain at 6 months after surgery for a lumbosacral radicular syndrome.

Key words: Lumbar disc surgery; physiotherapy; risk factors, prospective cohort study

Low back pain is one of the most common musculoskeletal disorders and is a major, costly problem in industrialized countries (Deyo & Phillips, 1996; Waddel, 1996). In 5-15% of all back disorders is the pathomechanism of pain known, such as lumbosacral radicular syndrome (LRS) (Spitzer et al., 1987; Koes et al., 2001). In LRS, pain is due to mechanical and/or chemical irritation of a lumbar or sacral nerve root by extended disc material (Nachemson, 1992). In about 30% of patients LRS is accompanied by sensory loss and motor disturbances (Eysel et al., 1994). The estimated annual incidence of LRS in Western countries is 0.5% (Cherkin et al., 1994; Younes et al., 2006). While symptoms resolve spontaneously or with conservative treatment, 20-30% of patients continue to experience disability and pain for more than one year (Weber et al., 1993; Vroomen et al., 2000). In these patients surgery is recommended to remove the extended disc material (Gibson et al., 1999); however, about 30% of these patients continue to experience disability, pain, and loss of work capacity after surgery (Korres et al., 1992; den Boer et al., 2006[a]).

In the present study, postoperative treatment was prescribed to all patients, usually performed by physiotherapists, who were asked to follow the recommendations described in the mono-disciplinary consensus guideline 'postoperative treatment for LRS' of the Royal Dutch Society of Physiotherapy (van Bemmel et al., 1998). This guideline dates from 1998, and globally describes possible treatment goals and interventions. The aim of this study was to get more insight in the treatment after surgery for LRS. We exploratively examined the treatment time spent on the 4 main treatment goals described in the consensus guideline: 1. improving neuromusculoskeletal and movement-related functions; 2. improving activities and participation; 3. reduce pain; and 4. educating and advising patients about, for example, pathology or dealing with postoperative pain and the outcome disability and pain at 6 months after surgery for LRS. In addition, we studied the association between the frequency that physiotherapists chose predefined sub-goals to improve main treatment goals, the number of treatment sessions, physiotherapist characteristics and their relation with these outcome measures. Finally, we studied the association between the preoperatively measured patient related levels of fear of movement/(re)injury and passive pain coping and the choice of the treatment sub-goal to reduce these factors at the start of the postoperative treatment.

Method

Design

This study is part of a prospective study of patient-related factors that are predictive of disability and pain at 6 months after surgery for LRS (den Boer et al., 2006[b]). The sample consisted of 277 patients with LRS caused by a prolapsed or sequestered disc and in whom the L4, L5, or S1 lumbar or sacral nerve root was clearly compromised, as confirmed by operative findings. All patients undergoing surgery for LRS at one of the four participating Dutch hospitals UMC St Radboud (Nijmegen), Canisius Wilhelmina Ziekenhuis (Nijmegen), Rijnstate Ziekenhuis (Arnhem), Viecurie (Venlo) over a 2-year period were asked to participate in the study. Inclusion criteria were age older than 16 years, failure of conservative treatment, and an ability to understand and read Dutch. Exclusion criteria were previous back surgery and physical comorbidity that might interfere with postoperative rehabilitation. The decision for surgery was based on the neurosurgeons' assessments, according to national guidelines

(Stam, 1996). Approval for this study was obtained from the medical ethics committee of the University Medical Centre St Radboud Nijmegen

Postoperative physiotherapy treatment variables

All 277 patients were referred to physiotherapy postoperatively and the physiotherapists involved were asked to record information at the start of the treatment and, depending on the duration of treatment, at 6 weeks and at 12 weeks postoperatively. Information was recorded about the treatment time spent on improving the 4 main treatment goals: 1. improving neuromusculoskeletal and movement related functions; 2. improving activities and participation; 3. reduce of pain; and 4. education and advising patients about, for example, pathology, the expected course of recovery or how to deal with postoperative pain. Additionally, they were asked to record the frequency that they chose the predefined sub-goals to improve the neuromusculoskeleatal and movement related functions (i.e. improve mobility of the lumbar spine, improve of muscular stability of the lumbar trunk muscles, increase of muscle strength of the lumbar trunk muscles, reduce of antalgic posture and movement pattern of the lumbar spine, reduce tension of the back muscle, increase neural mobility), to improve activities or participation (i.e. changing and maintain body position, carrying, moving and handling objects, walking and moving, self care, household tasks, work and employment) and to reduce the patient related risk factors more fear of movement/(re)injury and passive pain coping. Finally, they were asked to record the number of treatment sessions.

Physiotherapist characteristics

Information about the physiotherapists was collected, such as age, years of work experience, number of patients with LRS treated postoperatively in the last 5 years (< 5, 5-10, 11-20, > 20), and specialization (manual therapy, sports physiotherapy, pelvic girdle therapy, geriatric physiotherapy, psychosomatic physiotherapy).

Patient outcome and predictors

The outcome disability and pain at 6 months after surgery for LRS was evaluated by means of a self-report questionnaire sent to the patients. Disability was assessed using the Dutch version of the Roland Disability Questionnaire (RDQ) (Gommermans et al., 1997), a 24-item questionnaire with a yes/no response format with scores ranging from 0 to 24 (24 indicates very severe disability) that asks patients about limitations experienced as a result of their back and/or leg pain during the past week. The questionnaire consists of items such as, "I walk more slowly than usual because of my pain" and "I dress more slowly than usual because of my pain". Pain intensity was measured using a 10-cm visual analogue scale (VAS) (Price et al., 1983). The scale ranges from 0-100 (100 indicates worst conceivable pain). Patients were asked to rate the average back pain and leg pain in the previous week.

In the same patient population, it has already been shown that more passive pain coping and more fear of movement/(re)injury predicted more disability and pain 6 months after surgery for LRS (den Boer et al., 2006[b]). Pain-related fear of movement/(re)injury was measured one day preoperatively with the recently adjusted version of the Tampa Scale of Kinesiophobia (TKS-AV, Goubert et al., 2004), which measures fear of increasing pain and physical injury

during physical activity. Passive pain coping was measured one day preoperatively with the Pain Coping Inventory (PCI), a pain-coping instrument that measures different cognitive (worrying) and behavioral (resting, retreating) methods of dealing with pain (Kraaimaat & Evers, 2003).

Data analysis

Paired t tests were used to investigate the mean change in disability and pain between day one preoperatively and 6 months postoperatively. Correlational analyses were used to determine association between the percentage of treatment time spent on the four main treatment goals, the number of treatment sessions and the outcome disability and pain at 6 months after surgery for LRS. T-tests were used to examine the difference between the choice of a predefined sub-goals of treatment (yes/no) and the outcome disability and pain 6 months postoperatively. To study the association between physiotherapist characteristics we used correlational analyses in case of the variables age, years of work experience and the number of patients with LRS treated postoperatively in the last 5 years. The T-test was used to study the association between the dichotomous variable specialization (manual therapy, sports physiotherapy, pelvic girdle therapy, geriatric physiotherapy, psychosomatic physiotherapy) and the outcome disability and pain at 6 months after surgery, as well as for the, by the physiotherapist chosen sub-goal reduce fear of movement/(re)injury and passive pain coping and the preoperatively measured patient related levels of fear of movement/(re)injury and passive pain coping.

Results

Participating physiotherapists

In total 310 patients were subject of the study. Of these, 17 were not motivated for referral to postoperative treatment. The remaining 293 patients agreed to participate in the study. Some patients dropped out. Reasons for dropout of patients were 'repeated surgery for the same diagnoses within the follow-up period' (n = 2) and 'stopped due to lack of time' (n = 3).

A total of 130 physiotherapists agreed to participate. Of these physiotherapists, 51 dropped out and 79 provided a complete data-set. Reasons of dropout of physiotherapists were 'a lack of time for further participation' (n = 39) and 'stopped without giving a reason' (n = 12). From the data of the 79 physiotherapists with a complete dataset, 5 cases were not included in the study because the data of the patient at 6 months follow-up were missing.

Physiotherapists were asked record information at the start of the treatment and, depending on the duration of treatment, at 6 weeks and at 12 weeks postoperatively. Of the 74 physiotherapist, 20 stopped treatment within the first 6 weeks, 30 physiotherapists stopped treatment in the period between 6-12 weeks and 24 physiotherapists treated patients longer than 12 weeks.

Patient outcome

Six months after surgery there was a significant decrease in mean disability ($t = 15.71$, $p < 0.001$) and in pain ($t = 13.56$, $p < 0.001$). Patients (n = 74) who were treated by participating physiotherapists who provided a complete data-set reported significantly more decrease of disability and pain 6 months after surgery than the 203 patients for whom no or insufficient treatment information was registered ($t = -3.79$, $p < .001$; $t = -3.53$, $p < .001$), even though

Table 1. Percentages of the treatment time spent on improving the four main treatment goals at the start of treatment, at 6 weeks and 12 weeks after surgery.

Treatment goal	Week 0-6 (N = 74)	Week 6-12 (N = 54)	Week 12-24 (N = 24)
Improve neuromusculoskeletal and movement related functions	45.5	44.4	41.6
Improve activities and participation	25.3	30.6	31.1
Reduce pain	9.8	8.3	10.3
Information and education	20.4	16.7	17.0

there was no significant difference in disability and pain between the two groups at both time point one day before surgery and pain 3 days postoperatively.

Postoperative physiotherapy variables

Physiotherapist characteristics

The mean age of the participating physiotherapists (n = 74) was 42 years (range 22-59 years) and 30.3% were women. Their mean work experience was 18.2 years (range 4-33 years); 10% of the physiotherapists had treated 1-5 patients after surgery for LRS, 23.7% 6-10 patients, 32.5% 11-20 patients and 33.8% more than 20 patients. In total 46.6% of the physiotherapists were manual therapists and 26.9% were sports physiotherapists. No physiotherapist characteristics were significantly related to the outcome disability and pain at 6 months after surgery for LRS.

Content of postoperative physiotherapy treatment

The treatment time spent on the four main goals of postoperative treatment at the start of treatment, at 6 weeks and at 12 weeks is presented in Table 1. The mean proportion of

Table 2. Correlations between postoperative physiotherapy treatment variables and the outcome disability and pain at 6 months after surgery

Postoperative physiotherapy treatment variables	Disability 6 months postoperatively	Pain 6 months postoperatively
Number of treatment sessions	.13	.15
Improve functions	-.25*	-.33**
Improve activities and participation	.06	.08
Reduce pain	.03	.15
Information and education	.22	.21

* $p < .05$, ** $p < .01$

treatment time of the entire treatment period spent on interventions to improve neuromusculoskeletal and movement-related functions was 43.5% (SD = 19.1). These percentages were 28.1% (SD = 13.8) to improve activities and participation, 10.1 % (SD = 12.3) to reduce pain and 18.3% (SD = 14.7) to inform and advise patients about for example, the pathology, the expected course of recovery or how to deal with postoperative pain. Results from correlational analyses showed that more treatment time spent on improving neuromusculoskeletal and movement related functions was associated with less disability at 6 months follow-up (r = .25, p = .032) and pain (r = .33, p = .005) (see Table 2).

Sub-goals of postoperative physiotherapy treatment

The treatment sub-goals chosen by physiotherapists at the start of treatment, at 6 weeks and at 12 weeks postoperatively are presented in Table 3. The treatment sub-goals to improve neuromusculoskeletal and movement related functions that were most frequently chosen were "increase mobility of the lumbar spine", "increase muscle stability of the lumbar spine" and "increase trunk muscle strength of the lumbar spine". Less frequently chosen was the treatment sub-goal "normalize posture and movement pattern". The most frequently chosen sub-goals of treatment to improve activities and participation was walking and moving,

Table 3. Percentage of the treatment sub-goals chosen by physiotherapists

	Week 0-6 (N = 74)	Week 6-12 (N = 54)	Week 12-24 (N = 24)
Change of neuromuscoloskeletal and movement related functions			
Mobility of the lumbar spine	85.2	61.5	43.0
Stability of the lumbar spine	80.2	63.2	61.0
Strength of the back muscles	74.1	71.5	57.3
Antalgic posture and movement pattern	39.2	19.5	13.2
Tension of the back muscles	47.3	37.0	22.0
Mobility of the lumbar nerves	53.7	41.5	17.3
Change of activities and participation			
Changing and maintain body position	59.5	31.9	26.3
Moving and handling objects	46.0	20.1	22.0
Walking and moving	80.2	37.0	17.3
Self care	69.8	44.2	43.3
Household tasks	28.4	2.1	0.0
Work and Social activities	29.9	39.0	32.3
Change of personal factors			
Reduce passive coping with pain	52.3	44.6	39.3
Reduce fear of movement/(re)injury	55.3	38.5	33.7

self care and changing and maintain body position. Less frequently chosen treatment sub-goals were household task, and work and social activities. Results from t-tests showed that none of the treatment sub-goal chosen at the three different time points were significantly associated with the outcome disability and pain at 6 months after surgery. The at the start of the postoperative treatment chosen sub-goals reduce pain related fear of movement/(re)injury and passive pain coping were also significantly more frequently chosen for the patients who preoperatively reported higher levels of pain related fear of movement/(re)injury ($t = -.3.32$, $p = .001$) and more passive pain coping ($t = -2.83$, $p = .02$).

Number of treatment sessions

The mean number of treatment sessions was 18.8 (SD = 10.7). Results from correlation analyses showed that the number of treatment sessions was not significantly related to both outcome disability ($r = .13$, $p = .26$) and pain ($r = .17$, $p = .16$).

Discussion

Results of the study regarding the treatment time spent on improving the four main treatment goals showed that more treatment time spent on improvement of neuromusculoskeletal and movement related functions (e.g. "mobility of the lumbar spine", "muscle stability of the lumbar spine", "trunk muscle strength of the lumbar spine", "normalize posture and movement pattern") was associated with less disability and pain at 6 months after surgery. Several recently conducted studies (Hakkinen et al., 2003; Millisdotter et al., 2003; Manion et al., 2005; Dedering et al., 2006) support the existence of impairment in these functions and the association with more disability and pain at longer-term follow-up after surgery for LRS. These findings and the results of our study suggests that diminishing impairments of neuromusculoskeletal functions might be a successful treatment strategy to reduce disability and pain at longer term follow-up after surgery for LRS. However, this conclusion has to be drawn with caution, since the association between time spent on improving neuromusculoskeletal and movement-related functions and disability and pain at 6-month follow-up was only moderate. Furthermore, the patients (n = 74) who were treated by the physiotherapists who provided a complete data-set reported significantly less disability and pain at 6 months after surgery than the 203 patients for whom no information about the postoperative treatment was available, while between these groups there were no differences in disability and pain preoperatively and pain 3 days postoperatively, indicating the studied subgroup was not representative for the whole patient population. This may indicate that the physiotherapists who provided a complete data-set were more effective in their treatment or were, by completing the patient registration forms, forced to work in a more structured way, and therefore achieving better results.

Sub-goals of postoperative physiotherapy treatment

The sub-goal most frequently chosen to reduce neuromusculoskeletal and movement-related functions was "improvement of mobility of the lumbar spine". Results from a recently conducted study (Manion et al., 2005) gives support for the choice of this treatment goal. Firstly, it was shown that patients undergoing surgery for LRS had significantly less mobility of the

lumbar vertebral column (flexion and extension) than matched controls both shortly before and 2 months after surgery for LRS. Secondly there was a significant correlation between increased mobility of the vertebral column and fewer limitations in daily activities 2 months postoperatively. The next frequently chosen sub-goal was improvement of muscular stability of the lumbar spine and several studies provide a theoretical basis to support the choice of this treatment goal. Millisdotter et al. (2003) evaluated the presence of muscular stability in the deep segmental back muscles and proximal hip muscles in 58 patients before and after surgery. They found muscle dysfunction in 86% of the patients shortly before surgery and in 66% and 48% of the patients at 6 weeks and 6 months after surgery, respectively. The authors also found that greater muscle dysfunction at 6 weeks postoperatively was predictive of increased disability and pain one year after surgery. The least frequently chosen sub-goal was improvement of antalgic posture and movement functions. However, Leinonen et al. (2003) showed that, compared with healthy controls, at 3 months after surgery for LRS patients had impaired postural control, impaired lumbar movement perception and delayed reflex control of paraspinal muscles. In line with these results there is growing evidence that low back pain is associated with anticipatory postural and movement adjustments, consisting of stiffening the spine by co-contraction and delay or reduced activity of the deep lumbar trunk muscles (Hodges & Moseley, 2003; van Dieen et al., 2003; Moseley et al., 2004; O'Sullivan et al., 2005; Moseley & Hodges, 2007).

In patients with LRS, the extended disc material compressing the lumbar nerve root regulary causes a protective movement pattern (Manion et al., 2005; Millisdotter et al., 2003), which regularly enables the patients to participate in daily activities. However, an ongoing protective movement pattern postoperatively lead to increased compressive loads on spinal structures which is thought to predispose individuals to mechanically provoked pain. Finally, a recently conducted study (Thomas & France, 2007) showed that fear avoidance behaviour was associated with an alternative movement strategy of avoiding motion of the lumbar spine. A previous study in the same patient population on patient related risk factors showed that more pain related avoidance behaviour predicted more disability and pain at 6 months after surgery for LRS (den Boer et al., 2006[b]). However, there is a lack of studies examining the association between pain-related fear avoidance behaviour and avoidance of spinal motion during recovery after surgery for LRS. Based on the above mentioned study findings, and the rare choice of the sub-goal reduce of antalgic posture and movent pattern some improvements in the effectiveness of treatment after surgery for LRS may be gained by providing exercises that specifically focus on reducing antalgic posture and movement pattern or reduce pain related avoidance behaviour.

The sub-goals of treatment to improve activities and participation, improving household tasks, and work and social activities were relatively less frequently chosen. This might indicate that the physiotherapists focus more on specific neuromusculoskeletal and movement related functions and the more basic activities such as changing and maintain body position, moving and handling objects, walking and moving, but do not always integrate this specific exercises into the performance of more complex activities of daily living. Specific training of these limitations in activities and participation might lead to further improvements of the effectiveness of postoperative treatment.

The by the physiotherapists chosen sub-goals to reduce pain related fear of movement/(re)injury and passive pain coping at the start of the postoperative treatment were significantly more frequently chosen by physiotherapists for patients who reported higher levels of pain related fear of movement/(re)injury and passive pain coping. Results from a previous study in the same patients population showed that these factors were risk factors for an unfavourable outcome at longer term follow-up after surgery for LRS (den Boer et al., 2006[b]), and results of the present study suggests that these factors are regularly recognized as limitations for recovery after surgery for LRS. However, recognizing these risk factors does not mean that physiotherapists treated based on principles which were supposed to be effective to reduce pain related avoidance behaviour such as for example physical exercises based on principles of behavioural graded activity or exposure therapy of fear of movement/pain. Specifically since these treatment strategies are not described in the actual guidelines of postoperative treatment after surgery for LRS of the Royal Dutch Society of Physiotherapy.

Number of treatment sessions

Another notable finding of the study was that the number of treatment sessions was not related to the levels of disability and pain at 6 months follow-up, nor to any of the patient related risk factors after surgery for LRS, indicating that other variables are more decisive in stopping and continuing treatment after surgery for LRS. A number of explanations could be suggested, such as for example the attitude and knowledge of the physiotherapist, complexity of patient problems, access to health care providers, a maximum number of treatment paid by the health care insurance, motivation, expectations and desired goals of patients, which were possibly related to their physical work load, hobby's and/or sport. Future studies should investigate which factors are most decisive in the number of treatment sessions patients receive after surgery for LRS. A limitation of the study, however, is that we measured the outcome at 6 months follow-up. In the vast majority of cases this was not the time-point at which physiotherapists stopped treatment. Not having information about the disability and pain at the time of stopping postoperative physiotherapy treatment might have influenced the results, since the levels of disability and pain at 6 months follow-up might differ from these levels at the time-point physiotherapists stopped treatment. In line with these findings, a limitation of the actual guidelines of postoperative treatment for LRS is that no criteria are described when to stop postoperative treatment after surgery for LRS.

Conclusion

Results of the present study give some preliminary support that postoperative treatment specifically focussing on neuromusculoskeletal and movement-related functions, such as mobility, stability, muscle strength, posture, and movement pattern of the lumbar vertebral column, might lead to reduction of disability and pain at 6 months after surgery for LRS.

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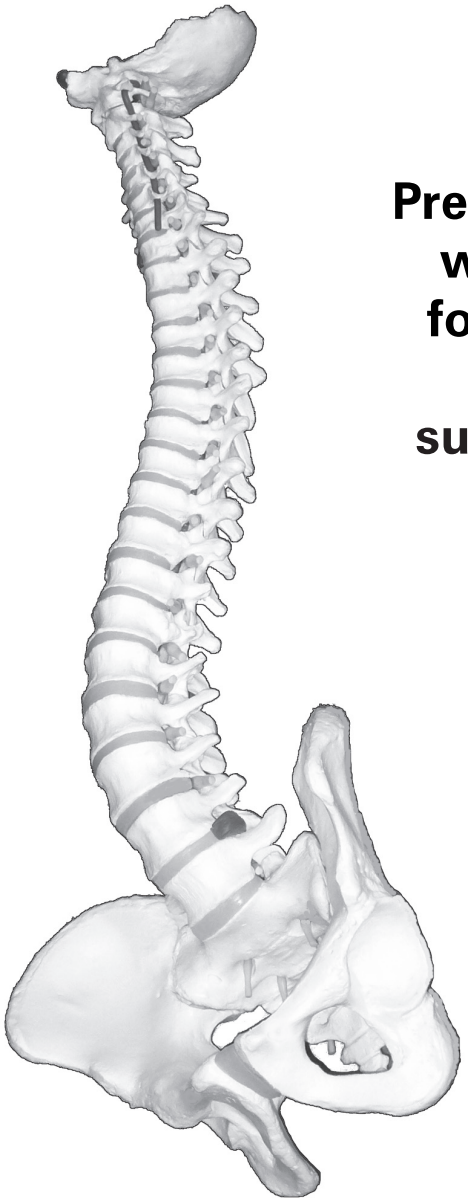


CHAPTER 7

Predicting disability, pain and work capacity after surgery for a Lumbosacral Radicular Syndrome: summary of the main results

The main goal of the present thesis was to identify at a relatively early postoperative stage risk factors of an unfavourable outcome of disability, pain and loss of work capacity at 6 weeks and 6 months after surgery for LRS, and to develop a screening instrument to identify patients at risk of residual complaints at 6 months follow-up. This chapter presents an overview of the main findings.

Systematic review

Chapter 2 describes a systematic review which summarizes the evidence concerning the predictive value of a broad set of clinical, demographic, cognitive behavioural and work-related factors with regard to the functional outcome of lumbar disc surgery. Medical and psychological databases were used to locate potentially relevant articles, which resulted in the selection of 11 studies. Each of these studies had a prospective design that examined the predictive value of preoperative variables for the outcome of lumbar disc surgery. Results indicated that a lower level of education, a higher level of preoperative pain, less work satisfaction, a longer duration of sick leave and higher levels of passive avoidance coping relatively consistently predicted an unfavourable outcome in terms of pain, disability, work capacity, or a combination of these outcome measures. However, the heterogeneity of the prognostic factors and outcome measures precluded the statistical pooling of the results of the various studies, and the methodological shortcomings of the studies included in the review asked for more prospective research.

Results of the prospective study: Outcome

In the prospective studies we focused on the outcome disability, pain, and work capacity at 6 weeks and 6 months after surgery for LRS. At 6 months mean disability and pain had decreased significantly, with the greatest decrease being detected in the first 6 weeks after surgery. After this period, disability still decreased significantly, but to a lesser extent, whereas pain intensity remained relatively stable. In the subgroup of 182 patients in paid employment before surgery 22.5% had not made a full return to work at the 6-month follow-up. In the present study, 79%, 77% and 82% of the patients had a clinically important decrease of disability, pain and loss of work capacity, respectively (> 30% improvement). However, when developing a screening instrument to predict residual complaints, we were specifically interested in those patients who still suffered of residual complaints after surgery for LRS, regardless of existent clinically important changes. Therefore, we used a cut-off score of outcome to detect all patients with residual complaints in one of the three outcome measures of disability, pain or work capacity. With this cut-off score, 51% of the patients were defined as having residual complaints.

Chapter 3 describes the results of a prospective cohort study that examined the predictive value of cognitive behavioural factors on the outcome measures disability and pain, at the short term (6 weeks) and longer term (6 months) follow-up in 277 patients undergoing surgery for LRS, taking into account the role of demographic variables (age, educational level, gender) and clinical variables (disability, pain, neurological deficits, intake of analgesics, duration of complaints preoperatively and pain 3 days postoperatively).

When comparing the relative contribution of cognitive-behavioural factors in multiple regression analyses, all independently predicted different outcomes. More fear of movement/(re)injury predicted less change in disability and pain intensity at the 6-week follow-up and less change in disability at the 6-month follow-up, more passive pain coping predicted less change in disability at the 6-month follow-up and negative outcome expectancies predicted less change in disability and pain intensity at both 6-weeks and 6-months after surgery.

Chapter 4 describes the results of a study that examined the role of both cognitive behavioural and work-related factors on the outcome work capacity at 6 months follow-up in the subgroup of 182 patients in paid employment before surgery, taking into account the demographic and clinical variables. Results from multiple logistic regression analyses indicated that more fear of movement/(re)injury, more passive pain coping and higher physical workload predicted reduced work capacity at 6 months after surgery for LRS.

Chapter 5 describes the development of the 'Nijmegen Outcome of Lumbar Disc surgery Screening instrument' (NOLDS) to identify patients at risk of residual complaints in one of the three outcome measures disability, pain or work capacity at 6 months after surgery for LRS. All clinical, demographic, and cognitive behavioural factors were included in a stepwise selection procedure of those factors that were most decisive in identifying patients at risk. Five factors were found to predict residual complaints at 6 months follow-up. In particular, lower level of education, older age, more pain 3 days postoperatively, use of more passive pain coping strategies and more fear of movement/(re)injury contributed significantly to the screening instrument. The discriminative power of the instrument was .78 (AUC).

Chapter 6 describes the results of a study examining the postoperative physiotherapy treatment characteristics. We exploratively examined the association between the treatment time physiotherapists spent on the main treatment goals:

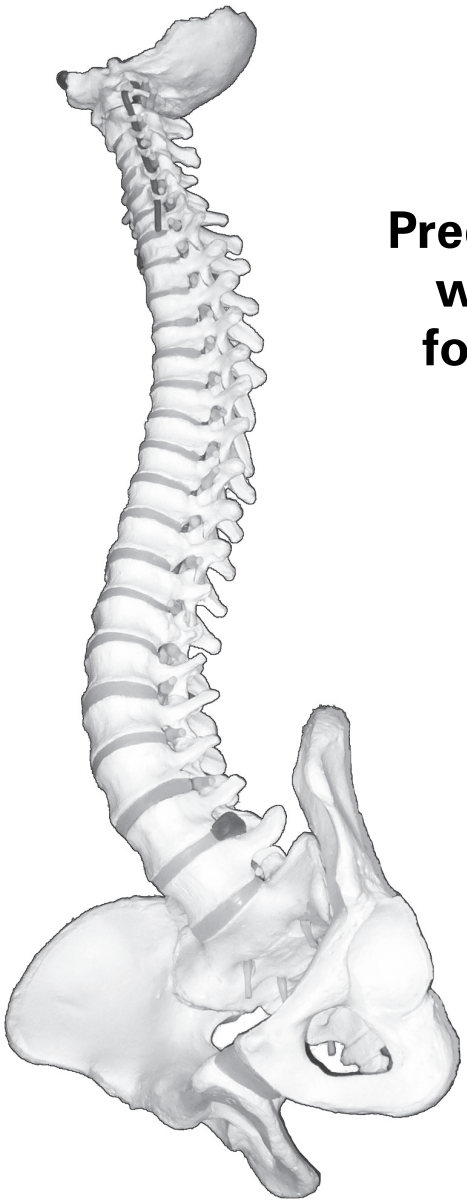
1. improving neuromusculoskeletal and movement-related functions;
2. improving activities and participation;
3. reduce pain;
4. educating and advising patients about, for example, pathology or dealing with postoperative pain and the outcome disability and pain at 6 months after surgery for LRS.

In addition we studied the association between the frequency that physiotherapist chose predefined sub-goals to improve the main treatment goals, the number of treatment sessions, physiotherapist characteristics and their relation with these outcome measures. Finally, we studied the association between the preoperatively measured patient related levels of fear of movement/(re)injury and passive pain coping and the choice of the treatment sub-goal to reduce these factors at the start of the postoperative treatment.

Results showed that more treatment time spent on improving neuromusculoskeletal and movement related functions was associated with less disability and pain at 6 months follow-up. In addition, the frequency therapists chose the the sub-goal to reduce more pain related fear of movement/(re)injury and reduce passive pain coping was higher for patients who were preoperatively characterized by more pain related fear of movement/(re)injury and passive

pain coping. The number of treatment sessions and the chosen sub-goals to improve the main treatment goals were not related to the outcome disability and pain at 6 months after surgery for LRS.

After a summary of the results in this chapter, chapter 8 presents an integrated overview of the main findings of these studies. The outcome of surgery is discussed first, followed by the variables that predict this outcome, the development of a screening instrument, postoperative physiotherapy treatment variables and methodological considerations. Finally, the general discussion will end with clinical implications, suggestions for future research and conclusions.



CHAPTER 8

Predicting disability, pain and work capacity after surgery for a Lumbosacral Radicular Syndrome: general discussion

The main goal of the present thesis was to identify at a relatively early postoperative stage risk factors of an unfavourable outcome of disability, pain and loss of work capacity at 6 weeks and 6 months after surgery for LRS, and to develop a screening instrument to identify patients at risk of residual complaints at 6 months follow-up. This chapter presents an integrated overview of the main findings of these studies. The outcome of surgery is discussed first, followed by the variables that predict this outcome, the development of a screening instrument, postoperative physiotherapy treatment variables and methodological considerations. Finally, the general discussion will end with clinical implications, suggestions for future research and conclusions.

Systematic review

The results of the systematic review indicated that the outcome of lumbar disc surgery is determined by a broad set of clinical, demographic, cognitive behavioural and work-related factors. The heterogeneity of the prognostic factors and outcome measures described in the literature precluded the statistical pooling of the results of the various studies, and the methodological shortcomings of the studies included in the review asked for more prospective research. Clinical, demographic, cognitive behavioural and work related factors were extracted from the review.

Results of the prospective study

Outcome after surgery for LRS

In the prospective studies we focused on the outcome disability, pain, and work capacity at 6 weeks and 6 months after surgery for LRS. All patients were operated on because the nerve root was clearly compromised by extended disc material, as was confirmed during surgery. At 6 months mean disability and pain had decreased significantly (Chapter 3), with the greatest decrease being detected in the first 6 weeks after surgery. After this period, disability still decreased significantly, but to a lesser extent, whereas pain intensity remained relatively stable. In the subgroup of 182 patients in paid employment before surgery 22.5% had not made a full return to work at the 6-month follow-up. In general, effectiveness of intervention is achieved when the levels of change represents a clinically important difference. For both the disability scores on the Roland disability questionnaire (RDQ) and the pain score on the visual analogue scale (VAS) the minimal clinically important improvement was a reduction of 30% of the baseline score (Jordan et al., 2006; Farrar et al., 2001). We used the same percentage for the outcome work capacity and when using this norm in the present study, 79%, 77% and 82% of the patients had a clinically important decrease of disability, pain and loss of work capacity, respectively. However, when developing a screening instrument to predict residual complaints, we were specifically interested in those patients who still suffered of residual complaints after surgery for LRS, regardless of existent clinically important changes. For example patients with relatively high preoperative levels of disability, pain and loss of work capacity can fulfill the criteria for clinically important improvements, but still have residual complaints. Therefore, to develop a screening instrument we used a cut-off score of outcome to detect all patients with residual complaints in one of the three outcome measures of disability, pain or work

capacity (Chapter 5). With this cut-off score 51% of the patients were defined as having residual complaints.

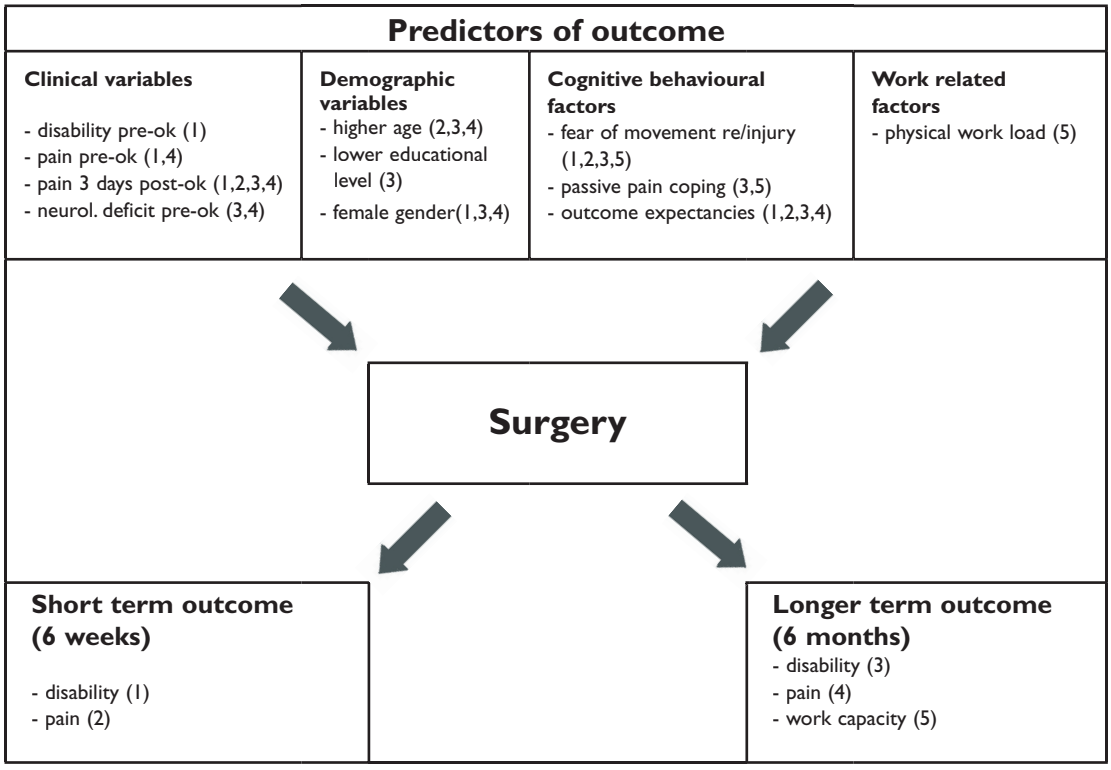
Predictors of outcome after surgery for LRS

We studied the relative contribution of the demographic (age, educational level, gender), clinical (disability, pain, neurological deficits, medication intake, duration of complaints preoperatively, pain 3 days postoperatively) and cognitive-behavioural factors (fear of movement(re)injury, passive pain coping, outcome expectancies) for the outcome of disability and pain at 6 weeks and 6 months after surgery for LRS (see Chapter 3 and 4). In the subgroup of 182 patients in paid employment before surgery we additionally studied the role of the work related factors (physical work load, job satisfaction, duration of sick leave) on the work capacity at 6 months after surgery. Results of the predictive value for the different outcome measures are summarized in figure 1. Overall, in addition to findings on nonspecific low back pain and other chronic pain populations, results of the present study showed the maladaptive long-term effects of demographic factors (lower educational level, higher age, female gender), clinical factors (more pain 3 days postoperatively, more neurological deficits), cognitive behavioural factors (more fear of movement/(re)injury, higher levels of passive pain coping and more negative outcome expectancies) and work related factors (higher physical work load) for the outcome after surgery for LRS measured at a preoperative and early postoperative stage. Finally, to develop a brief clinical screening instrument to assess the risk of residual complaints after surgery for LRS, we studied an outcome score including all three outcome measures disability, pain and work capacity at 6 months follow-up. Results showed that the factors age, educational level, pain 3 days postoperatively, fear of movement/(re)injury and passive pain coping significantly contributed to this definition of outcome. The factors that predicted an unfavorable outcome after surgery for LRS are discussed in the following paragraphs.

Demographic factors

Educational level

Results of our study showed that a lower educational level predicted more disability at 6 months follow-up. The predictive value of a lower level of education for an unfavourable outcome is in line with earlier findings on patients with non-specific low back pain (Dionne et al., 2001). The specific nature of this relationship is not entirely clear and could be caused by various factors. In a 7-year prospective observational study of 38426 employed people, Hagen et al. (2006) showed that a lower level of educational was associated with several work-related factors (lower authority to plan work, higher physical job demands, lower concentration and attention, and lesser job satisfaction) and individual lifestyle factors (more smoking, higher body mass index, and more alcohol consumption). In addition, Poiraudeau et al. (2006) showed that lower levels of education was associated with back pain related fear avoidance beliefs, and Callahan et al. (1996) showed that helplessness mediated the effect of educational level to mortality in rheumatoid arthritis patients. The wide variety of factors related to the level of education justifies more research.



1. outcome disability at 6 weeks follow-up.
2. outcome pain at 6 weeks follow-up
3. outcome disability at 6 months follow-up.
4. outcome pain at 6 months follow-up
5. outcome work capacity at 6 months follow-up

Figure 1. Significant preditcors of disability and pain at 6 weeks follow-up and disability, pain and loss of work capacity at 6 months follow-up from multiple regression analyses.

Age

Results of our study showed that a higher age predicted more pain at 6 weeks and more disability and pain at 6 months follow-up. Chronic low back pain affects at least 20% of the population older than 65 year (Lavsky-Shulan et al., 1985; Lyle et al., 2005) and it is generally thought that this back pain arise from degenerative processes which are ubiquitous in increasing age. The aging spine is often described with patho-anatomical terms such as spondylosis, vertebral ostheophythosis/osteoarthritis, spinal stenosis and disk disease (Beattie & Meyers, 1998). The degenerative process is determined by multiple factors and the source of pain is often unclear because of a weak association between neuroimaging studies and clinical presentation. However, it seems plausible that these degenerative changes, to some extent are associated with an increased risk of disability, pain and loss of work capacity. In addition other factors associated with age, such as for example less physical condition and decreased muscle strength (not measured in the present study) could as well be associated with both a higher age and an unfavourable outcome after surgery for LRS.

Gender

Results of the study showed that female gender predicted more disability at 6 weeks follow up and disability and pain at 6 months follow-up. A number of studies have demonstrated the predictive value of female gender for future disability and pain in chronic pain populations (Berkley, 1997; Uhnruh, 1999; Wiesenfeld-Hallin, 2005). Explanations of why such gender differences exists are wide ranging and multifactoral. For example biological, and cognitive behavioural factors have shown to be related to both pain and female gender. Of the various biological explanations, phase-related changes in pain across the menstrual cycle have led to suggestions that sex hormones play a role (Aloisi et al., 2005). Amongst the cognitive behavioural factors that have been implicated, more catastrophizing by females was found to mediate the relationship between gender and pain (Keogh & Eccleston, 2006). The variety of factors related to gender justifies more research.

Clinical factors

Pain intensity 3 days postoperatively and neurological deficits

Pain experienced 3 days after surgery for LRS most consistently predicted a diminished decrease in pain and disability at 6 weeks and 6 months after surgery. There is preliminary evidence that continuing nociception is associated with alterations in the peripheral and central processing of pain (Coderre et al., 1993; Woolf & Chong, 1993; Wilder-Smith et al., 2001; Giesecke et al., 2004; Suzuki & Dickenson, 2005). These alterations are also termed "neuroplasticity" or "central sensitization" and are suggested to be related to increased autonomic and muscular reactivity (Flor et al., 1990). In chronic conditions, these responses might develop into a consistent, habitual pattern of reactivity to pain and pain-related stimuli that affect pain and pain-related outcomes. Another factor of relevance to the studies described in this thesis which might contribute to sensitization of the central nervous system are neurological deficits caused by irreversible alterations of the spinal nerve root (Woolf et al., 1999; McCabe et al., 2007). In the present studies, neurological deficits predicted the future postoperative outcome of pain 6 weeks and 6 months after surgery. Further studies should examine the role of neuroplasticity in the development of chronic pain after surgery for LRS, and the relative contribution of neurological deficits to neuroplasticity.

Cognitive behavioural factors

Fear of movement/(re)injury

Fear of movement/(re)injury can be defined as an excessive, irrational fear of physical movement and activity resulting from a feeling of vulnerability to painful injury or re(injury). To our knowledge this is the first prospective study to investigate the predictive value of preoperative pain-related fear of movement/(re)injury on the outcome disability, pain and work capacity after surgery for LRS. Only one previous study examined the predictive value of pain-related fear of movement/(re)injury measured 6 weeks after surgery for LRS on pain, disability and perceived recovery at 3 months and 12 months after surgery (Ostello et al., 2005). This study did not find pain-related fear of movement/(re)injury measured at 6 weeks after surgery to be associated with the functional outcome of surgery for LRS. The lack of predictive value might be because only patients were included in the study who, according to the opinion of

the neurosurgeon, were not recovered at 6 weeks after surgery for LRS. Another possible explanation is that we found the decrease in disability and pain to be most obvious in the first 6 weeks after surgery, whereas Ostello et al. (2005) recruited patients after this period, so that the improvement of outcome might have been less pronounced, which would decrease the chance of detecting a significant association between fear of movement(re)injury and functional outcome of surgery for LRS.

The findings of our study adds to the widely established evidence on patients with non-specific chronic low back, that showed that more pain-related fear of movement/(re)injury is associated with impaired physical performance (Vlaeyen et al., 1995; Crombez et al., 1999; Al Obaidi et al., 2001; Swinkels et al., 2006) and increased self-reported disability (Asmundson et al., 1997; Crombez et al., 1999). Not only in condition with longstanding pain conditions, but also in patient populations with acute back pain, fear of movement/(re)injury have been shown to be associated with future disability, diminished participation, and loss of work capacity (Fritz et al., 2001; Swinkels et al., 2003), supporting the relevance of this factor also at a relative early stage of chronicity. The results show the possible relevance of the screening on pain related fear of movement/(re)injury at a preoperative stage in patients undergoing surgery for LRS, to identify patients at risk of an unfavorable functional outcome.

Passive pain coping

Pain coping can be defined as an individual's behavioural and cognitive attempts to manage or tolerate pain. The results from our study showed that preoperatively measured passive pain coping of avoidance behaviour and worrying predicted the outcome of disability and loss of work capacity at 6 months after surgery for LRS, and support the maladaptive effects of passive pain coping previous shown in other prospective studies on LRS (Rosenstiel et al., 1986; Graver et al., 1995; Fulde et al., 1995).

The results of the study adds to the emerging body of evidence of studies identifying passive pain coping as a risk factor in other chronic pain populations such as for example disabling neck and or low back pain (Weide et al., 1999; Mercado et al., 2005; Jones et al., 2006), rheumatoid arthritis and osteoarthritis (Lankveld et al., 1999; Scharloo et al., 1999; Steultjens et al., 2001; Evers et al., 1998), whiplash disorder (Söderlund & Lindberg, 1999; Bosma & Kessels, 2002) and mixed unexplained chronic pain patients (Samwel et al., 2006), which repeatedly have shown that more passive avoidant coping is related to worse future functional outcome, and underscore the importance of the preoperative screening on different coping strategies to identify patients at risk for an unfavorable functional outcome after surgery for LRS. In the present study we found that in LRS the passive pain coping strategy of retreating most consistently predicted disability at 6 months, suggesting that a tendency to avoid environmental stimuli when suffering from pain seems to be most decisive in continuing disability after surgery for LRS.

Negative outcome expectancies

Negative outcome expectancies consistently predicted disability and pain at both the 6 weeks and 6 months follow-up evaluations, showing that the patients idea that surgery might not resolve the pain problem affected future disability and pain. The results are in accordance

with research on general outcome expectancies (Mondloch et al., 2001), but extend findings by showing in a pathology with a relatively clear pain pathogenesis, negative outcome expectancies regarding result of surgery measured preoperatively predict the outcome of such an intervention. Recently, Ostello et al. (2005) also provided evidence of the maladaptive effects of outcome expectancies measured at 6 weeks after surgery for LRS, by showing that both negative expectancies of the outcome of surgery and negative expectancies of postoperative treatment predicted more disability and pain at 3 months and one year postoperatively. It is often suggested that expectancies regarding the benefit of a treatment may be an important part of what is called a placebo or non-specific effect. In a recent experimental study, Klinger et al. (2007) found support that a placebo effect reducing experienced pain in patients was achieved via both expectancies and classical conditioning.

Work-related factors

Physical workload

A higher physical workload (lifting heavy objects, repeated heavy arm tasks, and long-lasting standing and kneeling labour) predicted a reduced work capacity 6 months after surgery, independently of the predictive role of the cognitive behavioural factors of fear of movement/(re)injury and passive pain coping. These results contribute to the growing evidence from cross-sectional and prospective research (Wickström & Pentti, 1998; Crook et al., 2002; Elders et al., 2003) involving patients with non-specific low back pain that a higher physical workload is a risk factor for reduced work capacity in the long term.

We found that both higher levels of fear of movement/(re)injury and greater physical job demands independently predicted a reduced work capacity. Thus while a person should not be afraid to be physically active after surgery for LRS, being too physically active in the face of a high workload might contribute to a reduced work capacity. The effect of fear of movement might thus depend on various factors, and there may be times and situations when fear of movement is an adaptive strategy to prevent patients from a future loss of work capacity, such as in patients with a relatively higher workload shortly postoperatively. Future studies should examine the possible effects of fear of movement/(re)injury in patients with different workloads and at different times after surgery for LRS.

Job satisfaction

In our prospective study job satisfaction was associated with a reduced work capacity in univariate regression analysis, although it was not a significant predictor in multiple regression analyses when compared to all possible predictors. These findings are consistent with those of several studies of LRS and non-specific low back pain (Schade et al., 1999; Tubach et al., 2002; Gheldof et al., 2005; Shaw et al., 2006), which also showed that job satisfaction lost its importance when controlling for other factors, such as preoperative levels of pain and disability, income and physical workload. However, poor job satisfaction as an additional barrier to a return to work after surgery for LRS may result from several factors such as for example a lack of support, low decision latitude, job stress, an undesirable physical or psychosocial work environment, or monotonous work. These factors have also been shown to be associated with outcomes in previous studies of patients with non-specific low back pain (Crook et al., 2002;

Shaw et al., 2006). Thus matching a relevant intervention in individual patients would require a more detailed inquiry into job dissatisfaction.

Development of a screening instrument

We developed a brief clinical screening instrument, the 'Nijmegen Outcome of Lumbar Disc surgery Screening-instrument' (NOLDS), to assess the risk of residual complaints after surgery for LRS in one of the three outcome measures of disability, pain or work capacity. The NOLDS is based on five factors which were found to predict the outcome at 6 months after surgery for LRS. These factors are level of education, age, pain 3 days postoperatively, use of passive pain coping strategies and fear of movement/(re)injury. The results of the study extend those of previous work on non-specific low back pain (Linton et al., 1998; Reis et al., 2004; Hilfiker et al., 2007; Jellema et al., 2007) by showing that, in patients operated for LRS, it is possible to screen for the risk of symptom chronification using a short list of demographic, clinical and cognitive behavioral risk factors.

Since we want to identify the vast majority of patients with residual complaints 6 months following surgery we took a cut-off point on the NOLDS with a sensitivity of 90%. With this cut-off value (NOLDS > 47) 126 of the 141 patients with residual complaints 6 months following surgery for LRS were correctly identified 3 days following surgery. This high sensitivity of finding patients with residual complaints is accompanied with a relatively low specificity of 47%. This implicates that one needs to keep in mind that not all patients with a score higher then 47 on the NOLDS will have residual complaints.

The predictive value of the NOLDS might probably be further improved by not only screening in the early phase following surgery but also by repeatedly screening at different time-points at longer term follow-up after surgery for LRS. For example, Sieben et al. (2002) measured in patients with acute non-specific low back pain, pain related fear at different time points during the first 2 weeks after onset of complaints. Results showed that rising levels of pain related fear predicted more disability at one year follow-up.

Postoperative physiotherapy related variables

We exploratively examined the association between the treatment time physiotherapists spent on the main treatment goals: 1. improving neuromusculoskeletal and movement-related functions; 2. improving activities and participation; 3. reduce pain; and 4. educating and advising patients about, for example, pathology or dealing with postoperative pain and the outcome disability and pain at 6 months after surgery for LRS. In addition we studied the association between the frequency that physiotherapists chose predefined sub-goals to improve the main treatment goals, the number of treatment sessions, physiotherapist characteristics and their relation with these outcome measures. Finally, we studied the association between the preoperatively measured patient related levels of fear of movement/(re)injury and passive pain coping and the choice of the treatment sub-goal to reduce these factors at the start of the postoperative treatment.

About 30% of the physiotherapist participated in the study and recorded information about postoperative treatment in a structured way. Results of the study regarding the treatment time spent on improving the four main treatment goals, showed that more treatment time

spent on improvement of neuromusculoskeletal and movement related functions (e.g. 'mobility of the lumbar spine', 'muscle stability of the lumbar spine', 'trunk muscle strength of the lumbar spine', 'normalize posture and movement pattern') was associated with less disability and pain at 6 months after surgery. Several recently conducted studies (Hakkinen et al., 2003; Millisdotter et al., 2003; Manion et al., 2005; Dedering et al., 2006) support the existence of impairment in these functions and the association with more disability and pain at longer term follow-up after surgery for LRS. These findings and results of our study suggests that diminishing impairments of neuromusculoskeletal functions might be a successful treatment strategy to reduce disability, pain and loss of work capacity at longer term follow-up after surgery for LRS. However, this conclusion has to be drawn with caution, due to selected sample of physiotherapists, the role of possible other predictors and the modest association between time spent on improving neuromusculoskeletal and movement-related functions and disability and pain at 6-month follow-up.

The at the start of the postoperative treatment chosen sub goals of the physiotherapists to reduce pain related fear of movement/(re)injury and passive pain coping were more frequently chosen for patients with higher levels of preoperatively measured patient related levels of pain related fear of movement/(re)injury and passive pain coping. The results suggest that these factors are regularly recognized by physiotherapists as limitations for recovery after surgery for LRS. However, recognizing these risk factors does not mean that physiotherapists treated based on principles which are supposed to be effective to reduce pain related avoidance behaviour such as for example physical exercises based on principles of behavioural graded activity or exposure therapy of fear of movement/pain, specifically since these treatment strategies are not described in the actual guidelines of postoperative treatment after surgery for LRS.

Results of the study examining the number of treatment sessions showed that this was not related to the levels of disability and pain at 6 months follow-up, nor to any of the patient related risk factors after surgery for LRS, indicating that other variables are more decisive in the length of physiotherapy treatment after surgery for LRS. A number of explanations could be suggested, such as for example the attitude and knowledge of the physiotherapist, motivation or desired goals of the patient possibly related to their physical work load, access to health care providers or a maximum number of treatment paid by the health care insurance. Future studies should investigate which factors are most decisive in the number of treatment sessions patients receive after surgery for LRS.

Finally, a remarkable finding was that patients who were treated by the participating physiotherapists reported significantly less pain and fewer limitations in daily activities 6 months after surgery than the 203 patients for whom no information about the postoperative treatment was available, while between these groups there were no differences in disability and pain preoperatively and pain 3 days postoperatively. The study finding that the patients who were treated by these physiotherapists reported significantly less disability and pain at 6 months postoperatively may indicate that the participating physiotherapist were more effective in their treatment or were, by completing the patient registration forms, forced to worked in a more structured way, and therefore achieving better results.

Methodological considerations

Although our study included a substantial number of patients with pain of similar origin, had a relatively low percentage of dropouts, had a longitudinal design, and controlled for demographic and clinical variables, it had at least two main limitations, as discussed below.

Follow-up assessment

The follow-up time of 6 months could be considered relatively short. We chose it on the basis of previous studies that reported no significant decrease in pain between 6 months and longer follow-ups (Junge et al., 1995). Future studies have to replicate the findings for longer term follow-up. In addition, although we claim to have measured persistent complaints of disability and pain, our outcome was measured in two consecutive surveys at 6 weeks and at 6 months follow-up. Not having information about the disability and pain status between the two time points, it is possible that in some individuals we have identified recurrent complaints, rather than persistent complaints. Notwithstanding the fact that this may also be a valid outcome in general practice, this would serve to overestimate the prevalence of persistent complaints. Also regarding the outcome measure work capacity the exact date of recovery (e.g., return to work) was not determined, which this may have led to underestimation of the speed of recovery in interval between sampling time points.

Threats to internal validity

When monitoring a population over a longer period of time in a natural setting, conclusions about possible causal relationships between predictors and functional outcome could be threatened by internal validity. That is, other factors not measured in our study may affect the outcome and contribute to the relationships found in the study. While we controlled for a wide range of demographic and clinical variables derived from a systematic review of the literature (see Chapter 2), we cannot exclude the possibility that additional medical factors (e.g., disc degeneration, scar tissue), psychological factors (e.g., distress, hypervigilance), or social factors (e.g. social support) might also have contributed to the outcome of surgery for LRS.

Finally, measures used in the current studies were self report and they might be slightly confounded by cognitive and motivational factors. However, measurement scales used in the study were selected due to proven reliability, validity and widely use in studies on back pain and LRS populations.

Clinical implications and suggestions for future research

Risk factor screening is a first step to select patients at risk and to develop tailored approaches for early intervention strategies that might prevent patients from persistent disability, pain and loss of work capacity after surgery for LRS. Future studies in other populations of patients undergoing surgery for LRS are needed to further support the validity of the screening instrument. The next step to improve the effectiveness of postoperative treatment is matching individuals to intervention strategies based on the identified risk factors. In LRS, the effectiveness of postoperative physiotherapy treatment compared with no treatment has only been shown in more relief of pain and disability at short term follow-up (Ostello et al., 2003). The type of interventions that led to better results at short term follow-up varied

widely between the different studies ranging from early intensive exercises (Manniche et al., 1993; Kjellby-Wendt, 1998; Choi et al., 2003), specific stability training of the lumbar spine muscles (Filiz et al., 2004; Millisdotter et al., 2006), and neck massage (Erdogmus et al., 2007). However, no study provided tailored intervention based on individual risk factors, which might lead to better results at the longer term follow-up.

A number of studies on other pain populations provided evidence that customizing treatments to patient characteristics optimized treatment effects (George et al., 2003; Evers et al., 2003; Jellema et al., 2005). In addition, Shaw et al. (2006) recently analyzed 17 recent reviews on: "How well do intervention strategies match modifiable risk factors" in patients with sickness absence due to low back pain, and concluded that there was a strong risk factor concordance for graded activity/exposure, cognitive restructuring of pain beliefs and work place technical and organizational interventions. Several possible treatment strategies based on the risk factors identified in the present thesis are presented and discussed below.

Interventions to reduce the role of the cognitive behavioural factors of pain-related fear of movement/(re)injury and passive pain coping are based on anxiety theories, which propose that avoidance behaviour occurs in anticipation of pain rather than as a response to pain (Fordyce et al., 1982; Phillips, 1987; Kori et al., 1990). Depending on the risk factors involved, different techniques can be used in clinical pain practice, such as for example physical exercises based on principles of behavioural graded activity (BGA) or exposure therapy of fear of movement/pain. Patients are gradually exposed to activities using time contingent quota systems, including baseline determination and treatment contract. In BGA patients generally increases all types of activities, in exposure therapy of fear of movement/pain only those activities are selected that patients frightens most. We know of one randomized clinical trial comparing the effectiveness of BGA and usual care in patients after surgery for LRS (Ostello et al., 2003). In this study BGA was not more effective than usual care. The lack of effectiveness might be due to the fact that BGA was prescribed to all patients, and not solely to patients with increased levels of avoidance behaviour. Recently, George et al. (2003), using a sample of patients with low back pain, showed that patients with high scores of fear avoidance improved after fear avoidance-based physiotherapy, whereas individuals without pain-related fear experienced more disability after such treatment. In addition, Ostello et al. (2003) suggested that the more general exercises in BGA might not be specifically enough to reduce fear avoidance and that exposure therapy of fear of movement/pain might have led to more reduction of fear avoidance behaviour.

Another possible reason is that BGA does not include specific adjustments of posture and movement patterns, while there is growing evidence that low back pain is associated with anticipatory postural and movement adjustments. These adjustments consists of stiffening of the spine by co-contraction and delayed or reduced activity of the deep lumbar trunk muscles (Moseley et al., 2003; Hodges & Moseley, 2003; Van Dieen et al., 2003; O'Sullivan et al., 2005). In patients with LRS, Manion et al. (2005) showed that patients had significantly less mobility of the lumbar spine (flexion and extension) than matched controls shortly before and 2 months after surgery. In addition there was a significant association between decreased mobility of the lumbar spine and more disability two months postoperatively. A recently conducted study (Thomas & France, 2007) also showed that these alternative movement

strategies of avoiding motion of the lumbar spine were associated with more pain related fear. However, there is a lack of studies examining the association between pain-related fear avoidance behaviour and avoidance of spinal motion during recovery after surgery for LRS. Future studies examining these relation might give more insight in the predictive value of these factors of an unfavourable outcome after surgery for LRS.

Results from our study showed that also the cognitive behavioural factors of negative outcome expectancies and catastrophizing (as part of passive pain coping) were decisive in the prediction of disability and pain at the 6-month follow-up (Chapter 3). Consequently, cognitive techniques might be required to modify these risk factors, such as educational programs and cognitive-restructuring and coping-skill training to teach individuals how to most effectively stop and interrupt avoidance behaviour. For example, educate that many protective behaviors may ease the pain slightly in the short term, they are counterproductive in the longer term and even may increase pain through processes of hypervigilance or disuse of the musculoskeletal and cardiovascular systems. Interventions to modify negative outcome expectancies in patients with chronic pain can focus for example on increasing response expectancies. This might be achieved by providing a rationale in which pain is approached as something that can be influenced by changing the avoidance behaviour. Treatment can also be directed to modify the physiological response system directly, for example by reducing muscle tension. The above-mentioned treatment techniques could also be applied to eliminate possible fear avoidance beliefs of work-related activities. In addition, specific interventions to improve work capacity and reduce physical work load have a more ergonomic approach and focus on preventive interventions in the workplace, such as guidelines for ergonomic work environment, guidelines for acceptable workloads, guidelines for manual handling and loading skills (e.g. lifting techniques), and individual ergonomic adaptations of the workstation. Other interventions focus more on improving support from their supervisor, improving work place communication or encourage patients to examine possible career changes. Lastly, other pharmacological interventions directly focus on diminishing pain or reactivity to pain after surgery. There is preliminary evidence from two different controlled clinical trials involving 82 patients (Seskar et al., 2004) and 103 patients (Jiravattanaphochai et al., 2007) that pre-emptive analgesia with bupavicaine and tramadol leads to better postoperative pain relief shortly after surgery for LRS. The authors suggested that pre-emptive analgesia reduces sensitization of the central nervous system; however, there is still a lack of studies showing the effectiveness of pre-emptive medication on longer term functional outcomes after surgery for LRS.

Conclusion

1. Up to 50% of the patients suffer from residual disability, pain, or loss of work capacity up to 6 months after surgery for LRS.
2. Cognitive behavioural risk factors for more disability, pain and work capacity at 6 months after surgery are pain-related fear of movement/(re)injury, passive pain coping and negative expectancies regarding the outcome of surgery.
3. Physical work load is an additional predictor for less work capacity 6 months after surgery.
4. A screening instrument has been developed to identify patients at risk of residual complaints.

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Het voorspellen van beperking in dagelijkse activiteiten, pijn en werkcapaciteit na een operatie voor een Lumbosacraal Radiculair Syndroom

Samenvatting

Het Lumbosacraal Radiculair Syndroom (LRS) behoort tot de weinige ruggerelateerde aandoeningen waarbij de klachten kunnen worden verklaard op basis van relatief duidelijk aantoonbare pathologie, namelijk de druk van een uitpuilende tussenwervelschijf op een lumbale zenuwwortel. De symptomen bestaan hoofdzakelijk uit uitstralende pijn in het verzorgingsgebied van de beknelde zenuw. Bij ongeveer 30% van de patiënten gaat deze pijn gepaard met aan de gecomprimeerde zenuw gerelateerde krachtsverlies en stoornissen in het gevoel. LRS komt het vaakst voor tussen het 30e en 50e levensjaar met een jaarlijks voorkomen van 0.5% in de westerse wereld. Over het algemeen verdwijnen de klachten vanzelf of door middel van conservatieve behandeling, maar bij 20 tot 30% van de patiënten duren de klachten tot langer dan één jaar. De Nederlandse multidisciplinaire richtlijnen voor de behandeling van een LRS geven de aanbeveling om de uitpuilende tussenwervel operatief te verwijderen wanneer de klachten 6 weken na het ontstaan niet zijn verminderd. Afhankelijk van de gekozen uitkomstmaat heeft 20-50% van de patiënten nog beperkingen in dagelijkse activiteiten, pijn, en verlies van werkcapaciteit op langere termijn na de operatie. Aangezien het grootste deel van de directe en indirecte kosten voor rekening komt van deze relatief kleine groep patiënten, is een belangrijk doel van de postoperatieve interventie het verminderen van klachten en het voorkómen van chronische klachten.

Sinds de introductie van de gate-control theorie van Melzack en Wall in 1965 is er een verschuiving opgetreden van louter biomedische verklaringen voor pijn naar zogenaamde bio-psychosociale modellen. Het is nu algemeen geaccepteerd dat sensorische, affectieve en cognitieve factoren een belangrijke rol spelen bij het waarnemen van pijn, wat betekent dat ervaren pijn niet alleen een product is van opstijgende informatie vanuit perifere structuren, maar ook beïnvloed wordt door afdalende informatie vanuit het centrale zenuwstelsel. Een belangrijke aanname van bio-psychosociale modellen is dat bij de overgang van acute naar chronische pijn andere factoren een rol spelen dan de biomedische factoren die een belangrijke rol spelen bij het ontstaan van de klachten. In de laatste decennia heeft bijvoorbeeld empirisch onderzoek aangetoond dat diverse cognitief gedragsmatige en werkgerelateerde factoren een rol spelen bij het toekomstig klachtenbeloop. Zo is bijvoorbeeld relatief consistent aangetoond dat bij patiënten met aspecifieke rugklachten (klachten zonder duidelijk aantoonbare pathologie) meer angst voor pijn en nieuw letsel, een passieve manier van omgaan met pijn en negatieve verwachtingen van het herstel, een hogere fysieke werkbelasting en minder werktevredenheid een ongunstig klachtenbeloop voorspellen. Ook zijn het laatste decennium screenings-instrumenten ontwikkeld waarmee in een vroegtijdig stadium patiënten kunnen worden geïdentificeerd met een verhoogd risico op een ongunstig toekomstig klachtenbeloop bij patiënten met aspecifieke rugklachten.

Tot op heden ontbreekt het aan een systematisch overzicht van de literatuur betreffende risicofactoren voor een ongunstig klachtenbeloop na een operatie voor een LRS en aan een

screenings-instrument waarmee vroegtijdig patiënten met een verhoogde kans op behoud van klachten na een operatie voor een LRS kunnen worden opgespoord.

Het belangrijkste doel van dit proefschrift is het in een relatief vroegtijdig stadium identificeren van risicofactoren voor een ongunstig herstel wat betreft beperkingen in dagelijkse activiteiten, pijn en werkcapaciteit, gemeten 6 weken en 6 maanden na een operatie voor een LRS en het ontwikkelen van een screenings-instrument waarmee patiënten met een verhoogd risico voor een ongunstig herstel vroegtijdig kunnen worden opgespoord. Het zwaartepunt ligt hierbij op cognitef gedragsmatige en werkgerelateerde factoren, waarvan verondersteld wordt dat zij richtinggevend zijn voor de behandeling na een operatie voor een LRS. Ook is de relatie tussen diverse postoperatieve fysiotherapeutische behandelkarakteristieken en de mate van beperkingen in dagelijkse activiteiten en pijn 6 maanden na een operatie voor een LRS onderzocht.

Literatuuroverzicht

Allereerst is een systematisch overzicht van de literatuur gemaakt met betrekking tot voorspellende variabelen voor een ongunstig herstel na een operatie voor een LRS. De criteria van studies om opgenomen te worden in dit overzicht waren: 1. de gegevens waren prospectief verzameld; 2. het doel van de studie was het detecteren van voorspellende factoren voor het herstel na een operatie voor een LRS; 3. de behandelde groep bestond uit meer dan 30 patiënten; 4. de operatie was uitgevoerd alleen voor LRS en niet ook voor kanaalstenose; 5. de studie was uitgevoerd na 1980. Elf studies voldeden aan deze vijf criteria. De resultaten tonen aan dat een lager opleidingsniveau, meer preoperatieve pijn, minder werktevredenheid, een langere duur van de arbeidsongeschiktheid en een passieve manier van omgaan met pijn een ongunstig herstel na een operatie voor een LRS voorspellen. Echter, de heterogeniteit van de verschillende voorspellende variabelen en uitkomstmaten van de verschillende studies, en de methodologische tekortkomingen van de studies bleken te groot te zijn om de onderlinge studies statistisch te poolen. Meer gerichte studies zijn nodig om een beter gefundeerde uitspraak te doen over de variabelen die een behoud van klachten voorspellen na een operatie voor een LRS en die van belang zijn bij het identificeren van patiënten met een ongunstig klachtenbeloop.

Onderzoeksopzet

De onderzoekspopulatie bestond uit 336 patiënten met een LRS veroorzaakt door een discus prolaps of sequester met een duidelijk aantoonbare beknelling van de wortel van lumbale zenuw van L4, L5 of S1, bevestigd tijdens de operatie. Alle patiënten die zijn geopereerd in een van de vier deelnemende ziekenhuizen (UMC St Radboud Nijmegen, Canisius Wilhelmina Ziekenhuis Nijmegen, Rijnstate Arnhem, Viecurie Venlo) in een periode van twee jaar is gevraagd om mee te werken aan het onderzoek. Een complete dataset is verzameld van 277 patiënten. De vragenlijsten die zijn gebruikt werden geselecteerd op basis van bewezen betrouwbaarheid, validiteit, en regelmatig gebruik in ander onderzoek bij LRS en aspecifieke rugklachten. Op de dag voor de operatie is een breed scala aan gegevens in kaart gebracht, waaronder de demografische variabelen leeftijd, geslacht en opleidingsniveau, de klinische variabelen beperkingen in dagelijkse activiteiten, pijn, duur van de voorgeschiedenis en medi-

cijngebruik, de cognitief gedragsmatige factoren angst voor bewegen en nieuw letsel, een passieve manier van omgaan met pijn en negatieve verwachtingen van het herstel na de operatie, en de werk gerelateerde factoren fysieke werkbelasting, werktevredenheid en duur van de arbeidsongeschiktheid. Door middel van lichamelijk onderzoek werden de neurologische uitvalsverschijnselen door de klinisch fysiotherapeut gemeten. Drie dagen na de operatie werd opnieuw de mate van pijn gemeten.

Resultaten
De resultaten van de studie tonen aan dat 6 weken en 6 maanden na de operatie de mate van beperkingen in dagelijkse activiteiten en pijn significant zijn verminderd, met de grootste afname in de periode tot 6 weken na de interventie. Na deze periode nam de mate van beperkingen in dagelijkse activiteiten significant verder af, terwijl de mate van pijn nagenoeg gelijk bleef. Van de subgroep van 182 patiënten met betaald werk voor de operatie had 77.5% 6 maanden na de operatie het werk weer volledig hervat. In de regel wordt het effect van een interventie beoordeeld op een klinisch relevante verbetering van 30% ten opzichte van de situatie voor de operatie. Waneer we dit criterium hanteren, had in de huidige studie 79%, 77% en 82% van de patiënten klinisch relevante vermindering van respectievelijk 'beperkingen in dagelijkse activiteiten', 'pijn' en 'verlies van werkcapaciteit' 6 maanden na de operatie. Echter, ondanks deze klinische relevante verbetering kunnen patiënten nog steeds beperkingen in dagelijkse activiteiten, pijn en verlies van werkcapaciteit hebben en analyses gericht op behoud van klachten tonen aan dat 51% van de patiënten deze klachten 6 maanden na de operatie ondervindt.

De resultaten van een prospectief onderzoek waarin bij 277 patiënten de voorspellende waarde is onderzocht van de cognitief gedragsmatige factoren 'angst voor bewegen en nieuw letsel', 'een passieve manier van omgaan met pijn' en 'negatieve verwachtingen van het herstel' voor de mate van beperkingen in dagelijkse activiteiten en pijn 6 weken en 6 maanden na een operatie voor een LRS worden beschreven in hoofdstuk 3. Tijdens de analyses werd gecontroleerd voor demografische variabelen (leeftijd, opleidingsniveau en geslacht) en klinische variabelen (preoperatieve beperkingen in dagelijkse activiteiten en pijn, medicatiegebruik, duur van de voorgeschiedenis, neurologische uitvalsverschijnselen voor de operatie en meer pijn 3 dagen na de operatie). Resultaten van multiple lineaire regressie analyses toonden aan dat meer angst voor bewegen en nieuw letsel een voorspellende waarde heeft voor minder afname van beperkingen in dagelijkse activiteiten en pijn 6 weken na de operatie en minder afname van beperkingen in dagelijkse activiteiten 6 maanden na de operatie. Een meer passieve manier van omgaan met pijn voorspelde minder afname in beperkingen in dagelijkse activiteiten 6 maanden na de operatie en negatieve verwachtingen van het herstel na de operatie voorspelde minder afname van beperkingen in dagelijkse activiteiten en pijn op allebei de meetmomenten, 6 weken en 6 maanden na de operatie.

Onderzoek naar de voorspellende waarde van de cognitief gedragsmatige en werkgerelateerde factoren
In hoofdstuk 4 worden de resultaten beschreven van het prospectief onderzoek waarin bij de 182 patiënten met betaald werk voordat de huidige klachten zijn ontstaan, de voorspellende

waarde is onderzocht van de cognitief gedragsmatige factoren 'angst voor bewegen/nieuw letsel', 'een passieve manier van omgaan met pijn', 'negatieve verwachtingen van het herstel' en de werkgerelateerde variabelen 'fysieke werkbelasting', 'werktevredenheid' en 'duur van de arbeidsongeschiktheid' voor de mate van werkcapaciteit 6 maanden na een operatie voor een LRS, nadat is gecontroleerd voor demografische variabelen (leeftijd, opleidingsniveau en geslacht) en klinische variabelen (preoperatieve beperkingen in dagelijkse activiteiten en pijn, neurologische uitvalsverschijnselen, duur van de voorgeschiedenis, medicijngebruik en pijn 3 dagen na de operatie). Resultaten van multiple logistische regressie analyses toonde aan dat de voorspellende factoren voor werkhervatting 6 maanden na de operatie grotendeels overeenkomen met de voorspellende factoren voor de mate van beperkingen in dagelijkse activiteiten en pijn 6 maanden na de operatie en dat de cognitief gedragsmatige factoren meer angst voor bewegen/nieuw letsel en een passieve manier van omgaan met pijn verlies van werkcapaciteit 6 maanden na de operatie voor een LRS voorspelde. Een belangrijke aanvulling op de resultaten voor de mate van beperkingen in dagelijkse activiteiten en pijn is dat een hogere lichamelijke werkbelasting de mate van werkhervatting 6 maanden na de operatie negatief beïnvloedt.

Screening instrument

De ontwikkeling van een screening instrument '(Nijmegen Outcome of Lumbar Disc surgery Screening instrument' (NOLDS) wordt beschreven in hoofdstuk 5. Hiermee kunnen patiënten met een verhoogd risico op aanhoudende klachten op een van de drie uitkomstmaten beperkingen in dagelijkse activiteiten, pijn en werkcapaciteit 6 maanden na de operatie voor een LRS vroegtijdig worden opgespoord. De demografische variabelen (opleidingsniveau, leeftijd, geslacht), klinische variabelen (neurologische uitvalsverschijnselen, pijn 3 dagen na de operatie) en cognitief gedragsmatige factoren (angst voor bewegen/nieuw letsel, een passieve manier van omgaan met pijn, negatieve verwachtingen van het herstel) die in de eerdere studies een voorspellende waarde hadden voor een ongunstig klachtenbeloop na de operatie, werden gelijktijdig ingevoerd in een stapsgewijs logistisch regressiemodel met een selectieprocedure met voorwaartse selectie. Hiermee werden de variabelen met de sterkst voorspellende waarde voor het identificeren van patiënten met een verhoogd risico op aanhoudende klachten geselecteerd.

De vijf factoren 'een lager opleidingsniveau', 'een hogere leeftijd', 'meer pijn 3 dagen na de operatie', 'meer angst voor bewegen/nieuw letsel' en 'een passieve manier van omgaan met pijn', bleken een significante bijdrage te leveren aan het identificeren van patiënten met een verhoogd risico op aanhoudende beperkingen in dagelijkse activiteiten, pijn en verlies van werkcapaciteit 6 maanden na een operatie voor een LRS. Het discriminerend vermogen van het model was .78 (AUC).

Fysiotherapeutische behandelkarakteristieken

De resultaten van een verkennende studie naar postoperatieve fysiotherapeutische behandelkarakteristieken worden in hoofdstuk 6 beschreven. Aan alle eerstelijns fysiotherapeuten, die betrokken waren bij de nazorg van patiënten in de studie, is gevraagd om gegevens te verzamelen over de behandeling. Vervolgens is de associatie onderzocht tussen enerzijds de door

de fysiotherapeut gerapporteerde tijd van de behandeling die werd besteed aan: 1. verbeteren van neuromusculaire en bewegingsgerelateerde functiestoornissen; 2. verbeteren van activiteiten en participatie; 3. verminderen van pijn; 4. het informeren en adviseren van patiënten over bijvoorbeeld de pathologie, het omgaan met pijn en anderzijds de door de patiënt gerapporteerde mate van beperkingen in dagelijkse activiteiten en pijn 6 maanden na de operatie.

Aanvullend hebben we de associatie onderzocht tussen enerzijds de door de fysiotherapeut gestelde subdoelen (b.v. verbeteren van de beweeglijkheid van de lumbale wervelkolom, verbeteren van de spierkracht rond de lumbale wervelkolom, optimaliseren van houding- en bewegingscoördinatie, lopen, tillen, etc.), het aantal behandelsessies en verschillende kenmerken van de fysiotherapeut (leeftijd, werkervaring, specialisatie) en anderzijds de mate van beperkingen in dagelijkse activiteiten en pijn 6 maanden na de operatie. Als laatste is de associatie onderzocht tussen de frequentie van de door de fysiotherapeut gekozen subdoelen verminderen van angst voor bewegen/nieuw letsel en omgaan met pijn en de patiëntgerelateerde mate van angst voor bewegen/nieuw letsel en de passieve manier van omgaan met pijn en anderzijds de bij de start van de behandeling door de fysiotherapeut gekozen subdoelen om deze factoren te verminderen.

De resultaten van de studie toonden aan dat wanneer fysiotherapeuten meer tijd van de behandeling besteden aan het verminderen van neuromusculaire en bewegingsgerelateerde functiestoornissen, de patiënt 6 maanden na de operatie significant minder beperkingen in dagelijkse activiteiten en pijn had. Ook was de frequentie van de bij de start van de behandeling door de fysiotherapeut gekozen behandel subdoelen 'verminderen van angst voor bewegen en nieuw letsel, en 'verminderen van een passieve manier van omgaan met pijn' significant hoger bij patiënten met meer angst voor bewegen/nieuw letsel en een meer passieve manier van omgaan met pijn. Het aantal behandelsessies, de keuze van de fysiotherapeutische subdoelen en de karakteristieken van de fysiotherapeut waren niet gerelateerd aan de mate van beperkingen in dagelijkse activiteiten en pijn 6 maanden na de operatie.

Discussie

Het onderzoek heeft aangetoond dat patiënten met een verhoogd risico op een ongunstig herstel relatief consistent en vroegtijdig kunnen worden opgespoord door middel van een beperkte set van demografische, klinische, cognitief gedragsmatige en werkgerelateerde factoren. De resultaten van de studie geven aanleiding om op maat gemaakte behandelprogramma`s te ontwikkelen, al moet de effectiviteit van deze behandelprogramma`s eerst nog aangetoond worden. Een aantal mogelijke behandelopties, gebaseerd op de risicofactoren wordt kort besproken. Aangezien de cognitief gedragsmatige variabelen 'meer angst voor bewegen' en 'een passieve manier van omgaan met pijn' (rusten, piekeren en terugtrekken van dagelijkse activiteiten) belangrijke risicofactoren zijn voor een ongunstig herstel, is het te verwachten dat een postoperatieve nabehandeling die zich op deze factoren richt het herstel na een operatie gunstig kan beïnvloeden. Hierbij nemen we aan dat deze patiënten slecht herstellen omdat ze vermijdingsgedrag vertonen, en dat cognitief gedragsmatige therapie, die zich met behulp van gestructureerde interventies zoals graded activity of graded exposure richt op het verminderen van dit gedrag leidt tot minder beperkingen in dagelijkse activiteiten, pijn en verlies van werkcapaciteit op langere termijn na een operatie voor een LRS.

Een factor gerelateerd aan vermijdingsgedrag waar toenemend bewijs voor wordt gevonden is dat patiënten met een LRS zichzelf, anticiperend op pijn, een beschermend houding- en bewegingspatroon aanleren, dat vaak lijdt tot verstijving van de rug. Vóór de operatie is dit patroon vaak functioneel om zoveel mogelijk te kunnen blijven participeren in dagelijkse activiteiten. Recente studies suggereren dat behoud van klachten na de operatie gepaard gaat met handhaving van dit beschermend houding- en bewegingspatroon en dat een fysiotherapeutische nabehandeling die zich specifiek richt op het afleren van deze beschermende houdingen en bewegingen leidt tot een grotere afname van de postoperatieve klachten dan met standaard fysiotherapie bereikt wordt.

De voorspellende waarde van fysieke werkbelasting voor een ongunstig herstel geeft verder aanleiding om de postoperatieve interventie ook specifiek te richten op ergonomisch aanpassingen op de werkvloer, aanleren van tiltechnieken en het opstellen van richtlijnen voor variatie in werkhouding en het tillen van zware lasten.

De voorspellende waarde van pijn 3 dagen na de operatie geeft aanleiding het effect van farmacologische interventies ter vermindering van pijn te onderzoeken, en er zijn recent aanwijzingen in de literatuur gevonden dat pijnstilling tijdens de operatie leidt tot vermindering van pijn op korte termijn na de operatie voor LRS ten opzichte van placebo therapie. De auteurs van deze onderzoeken suggereren dat dit effect werd bewerkstelligd door een vermindering van activiteit van het centrale zenuwstelsel (centrale sensitisatie). De effecten hiervan op langere termijn zijn nog niet onderzocht.

Conclusies

1. Circa 50% van de patiënten heeft nog pijn, beperkingen in dagelijkse activiteiten en verlies van werkcapaciteit 6 maanden na een operatie voor een LRS.
2. Cognitief gedragsmatige risicofactoren voor meer beperkingen in dagelijkse activiteiten, pijn en verlies van werkcapaciteit zijn 'meer angst voor bewegen en nieuw letsel', 'een passieve manier van omgaan met pijn' en 'negatieve verwachtingen van het herstel na de operatie.
3. Fysieke werkbelasting is een aanvullende risicofactor voor de mate van werkhervatting 6 maanden na een operatie.
4. Een screening instrument is ontwikkeld waarmee, op een relatief vroegtijdig tijdstip, patiënten kunnen worden opgespoord met een verhoogd risico op aanhoudende klachten na een operatie.

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Jasper

Curriculum vitae

Jasper den Boer was born on November 8, 1968 in Oosterbeek (municipality Renkum), the Netherlands.

He obtained his HAVO diploma in 1986 at the Liemers College in Zevenaar. He then started his physiotherapy study at the college of physiotherapy in Arnhem and graduated in 1991.

He served his army duty as a physiotherapist and worked in the Military Rehabilitation Centre in Doorn, where he participated in a project developing guidelines for post-operative treatment after surgery for a Lumbosacral Radicular Syndrome (LRS).

During 1991 and 1992 he worked in various private practices in primary health care setting.

In 1994 he started the study manual therapy at the free University in Brussels, Belgium, were he graduated in 1998. His master's thesis focused on a review and a pilot study of a research protocol on predictors of outcome after surgery for LRS.

In 1997 he started to work as a clinical physiotherapist at the University Medical Centre St Radboud in Nijmegen. He worked at the clinical departments of neurosurgery, neurology and geriatry. In 1998 he participated in the development of the consensus guideline 'postoperative treatment of LRS', developed by the Royal Dutch Society of Physiotherapy.

From 2002 to 2008 he worked part-time as a physical physiotherapists and part-time as a junior researcher and carried out the studies included in this thesis.